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ABSTRACT

This practicum addressed the problem of inadequate teacher preparation in the area of learning theory, content, and methodology related to mathematical instruction of children attending a private child care center in Oakland, California. The general goal of the study was to plan, implement, and evaluate a staff development program to increase teacher competency, while increasing interest and enthusiasm in teaching early childhood mathematics and promoting planned and systematic implementation of mathematical experiences for children. Basic information about early concepts and the developmental facts about the child's acquisition of each specific concept were provided in a teacher handbook titled, "Young Children's Mathematics - A Handbook for Teachers in Child Care Centers and Preschools." The handbook also offered examples of formal and informal opportunities to foster concept formation. Also, to assist teachers in the preparation of planned mathematical experiences, an activity file was prepared. Requiring extensive and active staff participation, these materials were employed during the 12 weeks of program implementation. Evaluation data indicated that participants increased their knowledge of mathematical content and their ability to plan and present mathematical activities to young children. Furthermore, participants succeeded in involving parents in the mathematical learning experiences of their children. Related materials are appended, including evaluation instruments, the handbook, and the activity file. (RH)

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A Staff Development Program to Increase Teacher Competency in Mathematics Education For the Early Years

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A Staff Development Program to Increase Teacher Competency in Mathematics Education For the Early Years

by

Dora Halperin
Cluster IX

PS 015454

A Practicum Report Presented to the Ed.D. Program
in Early Childhood
in Partial Fulfillment of the Requirements
for the Degree of Doctor of Education

NOVA UNIVERSITY
1985

A STAFF DEVELOPMENT PROGRAM TO INCREASE TEACHER COMPETENCY IN MATHEMATICS EDUCATION FOR THE EARLY YEARS

Practicum I

Submitted to

the Faculty of the Early Childhood Education Program

In Candidacy for the Degree of

Doctor of Education

by

Dora Halperin

Nova University

Cluster IX

June 1985

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This practicum report was submitted by Dora Halperin under the direction of the reviewer listed below. It was submitted to the Ed.D. Program in Early Childhood and approved in partial fulfillment of the requirements for the degree of Doctor of Education in Early Childhood at Nova University.

Approved:

July 8, 1985
Date of Final Approval of Report

Jeri Sorosky, Ed.D.

ABSTRACT

A Staff Development Program to Increase Teacher Competency in Mathematics Education for the Early Years.

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Descriptors: Concept Formation/Mathematical Concepts/ Mathematics Instruction/Number Concepts/Preschool Children/ Preschool Education/Preschool Teachers/Teaching Guides/ Teaching Methods/Teacher Role.

This practicum addressed the problem of inadequate teacher preparation in the area of early childhood mathematics. The importance of incidental and formal mathematical instruction during the preschool years was established through questionnaires and supported by recent research findings.

The writer's goal was to plan, implement, and evaluate a staff development program in order to provide teachers with the knowledge and practice necessary to foster mathematical learning in young children. It was expected that a greater understanding of mathematical concepts, teaching strategies, and cognitive development would promote interest and enthusiasm in teaching early childhood mathematics.

The results indicate that the goal of the practicum was achieved in a significant degree. The participants increased their knowledge of mathematical content and their ability to plan and present mathematical activities to young children. Furthermore, participants succeeded in involving parents in the mathematical learning experiences of their children.

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CHAPTER ONE

Introduction

A. The Writer and the Work Setting

The writer of this proposal is the owner and director of The Rainbow School, a private child care center serving twenty-six families in Oakland, California. The center was established in January, 1978. It occupies a remodeled single-family home on a quiet street in a residential neighborhood. The large main room is divided by shelves into smaller activity areas (blocks, art, manipulatives). A loft creates a small housekeeping area below and a private space with pillows and soft toys above. A couch, the piano, a rug, books and several big pillows create an area that is often quiet but that is also the setting for the daily circle time and the weekly music session. Once a week all furniture is moved toward the walls, and the room turns into an open space for dance and movement.

The small office is at the same time the staff room and the storage room. The kitchen is used for the preparation of snacks, for cooking projects. Its low, round table is the focus for small group work. The center serves a morning and an afternoon snack while lunch is sent by the parents.

The outside space is articulated into areas with flexible boundaries. An arbor offers transition from the

inside space; under it three redwood tables are used for meals most of the year. Art projects frequently take place here and on the easels on the nearby fence. Wood chips cover the ground under the climbing structure, the tire swing, and the slides. A large willow tree shades the sandbox in summer. There is a paved area for running and bike riding and a corner for large blocks, while the log cabin stimulates dramatic play.

The center is open year-round, five days a week from 7:30 a.m. to 5:30 p.m. All children attend full days, although the hours may vary according to the parents' needs. Children arrive and leave at different times, a fact that requires great resourcefulness on the part of the teachers in scheduling activities and group work so that every child is included. Naptime provides a respite in the middle of a busy day. Children rest for approximately two hours after listening to stories or chapters of a book read by the teacher.

The program is complemented by regular field trips to museums, parks, farms, the Lawrence Hall of Science and the monthly movie show at the Pacific Film Archive. Parents participate in these outings to help with transportation and to assist in supervising the children.

The center employs three teachers. The staff is assisted by two specialists who work in weekly sessions

with the children in the areas of creative movement and music. A psychologist is in charge of staff meetings, mediates conflicts, and advises on problems related to child behavior, discipline, and parent-teacher communication.

The mimimum educational requirement for the teaching staff is the California Children's Center Permit, which represents a combination of two years of coursework in early childhood education and at least one year of pracitcal experience. Teachers now working at this center exceed these requirements. The head teacher holds a bachelor of arts degree in education and is working towards her master's degree. She has been at The Rainbow School for six years. The other teachers started working at the center in the course of last year; one holds an associate degree in family studies and the other a bachelor of arts degree and a kindergarten teaching credential

The selection of expert early childhood teachers is a difficult task in this area of the country. Teacher preparation programs at the University of California and the community colleges have been affected by budget cuts. With fewer courses offered, it takes longer to fulfill the credentialing requirements. In addition, many of those who graduate decide to pursue a better-paying career.

Conversely, many look for jobs with young children, but they lack the qualifications necessary for employment in a state-licensed center.

As owner, director, and full-time teacher, the writer's responsibilities are varied and challenging. They include, but are not limited to, the following:

1. all administrative duties;
2. the hiring and firing of staff;
3. staff development, supervision, evaluation, and meetings;
4. recruitment, interviews of new children and their parents, parent meetings, individually and in groups;
5. teaching, supervision, observation, and biyearly assessment of children;
6. curriculum design and implementation;
7. purchase of equipment and supplies.

Many of these tasks are shared by all the teachers, especially the planning of the day-to-day activities, organization of field trips, daily communication with parents, and the daily work with the children at the center. Teaching is viewed as team work. Communication among the teachers is valued and encouraged. Informal planning and discussion occur almost every day, and a formal staff meeting is called once a month.

Each teacher contributes in the area of her/his particular strength or inclination, a model that has the virtue of injecting enthusiasm and creativity into everyday activities, but it also has the disadvantage that certain curriculum areas may be disregarded completely. Teachers in this particular setting chose to emphasize social and emotional growth through activities such as story reading, cooking and art projects, and large blocks of time set aside for free play. Activities involving classification, seriation, or quantification were seldom if ever planned by the staff, although one of the explicit goals of the center is to promote cognitive growth and foster the development of intellectual and academic skills.

B. The Community

This child care center was established by the writer six years ago in a residential section of Oakland, California close to the exclusive area of expensive Oakland and Berkeley hills homes. Oakland has a population of 340,000. It is the county seat of Alameda County which has a population of 1,200,000. Housing is sufficient to permit selectivity. Prices vary from $60,000 to $300,000 for a three-bedroom house.

There are currently 3,350 industrial plants in Oakland/Alameda County. The leading classes of products are

processed foods, office equipment, calculating and data processing machines, chemicals, printing, and publishing. Permanent government installations give further economic stability to the area. These include the United States Naval Supply Center, Alameda Naval Air Station, and the Oakland Army Base. Kaiser Aluminum and Chemical Company, Clorox Corporation and Foremost-McKesson, Inc. each operate large research technical facilities in the area (Oakland Chamber of Commerce brochure, 1982).

Oakland is one of America's most politically, culturally, and economically integrated cities. It has a black middle class estimated to be the largest outside of Atlanta. It has a black mayor, a black city manager, black majority in the city council, and a black editor of the Oakland Trubine. It has a large Asian and Pacific Island population as well. The earlier-settled Asian groups are being joined by a new wave of recent immigrants who are rapidly finding ways to live. Like any California city, Oakland also has a large Hispanic population, mainly of Mexican origin. Meanwhile, young white families and single people are moving back into urban neighborhoods. In banks, office buildings, classrooms and courtrooms, on the job and at play, Oaklanders are thoroughly mixed and learning to enjoy their diversity.

A city of rich traditions dating back to the days of the Gold Rush, Oakland has languished in the shade of San

Francisco until quite recently. The factors that determined the city's earlier growth--an excellent harbor and a pivotal location as a transportation hub--are still valid, and the business community is looking to Oakland for its future. New construction under way includes the City Center with its new Convention Center, the TransPacific Center, the Clorox Building and the Wells Fargo Building. Also, some of the proudest commercial buildings from the Progressive era have been restored.

In the neighborhoods, the same kind of renewal is going on. Attractions include the lure of a pleasant climate and the ease of commuting to San Francisco. The long-time residents and the newcomers formed strong organizations to foster pride in their neighborhoods, to address common concerns, and to help rehabilitate older homer (Bagwell, 1982).

The North Oakland/Rockridge area where the center is located evolved in the recent past into a most pleasant combination of small shops, antique stores, restaurants, and affordable housing. Its proximity to freeways and the rapid transit system made it a favorite among young professionals who work in San Francisco. The hills area with its expensive homes rises barely a few blocks east of this center.

Parents who enroll their children in the center belong

to a rather homogeneous segment of society: they are lawyers, physicians and nurses, university professors, computer experts, or genetic engineers. Typically, the child belongs to a two-parent family where both partners work full time in a professional capacity. Families own their home and frequently a weekend house, too. These socio-economic characteristics explain the great stability of the center's population. Children stay at the center for at least two years, although three years is the typical length of attendance. Very often one or even a second sibling will be enrolled in succession. Approximately 25 percent of the children are black, Asian or Hispanic.

Parents have no time or inclination for any consistent involvement other than the occasional participation in a field trip. The main topic of interest among the parents is the issue of the early acquisition of academic skills. Parents agree that young children need ample time to play and acquire social skills. On the other hand, they expect that their children will be instructed in reading, early writing, and mathematics in order to pass the rigorous entrance examinations required by the area's prestigious private elementary schools.

CHAPTER TWO

Study of the Problem

A. Statement of the Problem

This center was established in 1978 with the goal of providing children with opportunities for socio-emotional growth through creative play, art, music, and the shared daily routines. Although interesting materials were presented to provide for cognitive growth, no attempt was made to structure these experiences. The program did not include activities whose main objective would have been the attainment of early academic skills. The preschool years were seen as a time for free play and exploration.

A gradual change of the socio-economic composition of the center's clientele, now attracting parents of higher income, and the increased demands of private and public kindergartens determined the need for a greater emphasis on cognitive and academic skills. The daily schedule was changed to include small-group work in reading and mathematical skills. Circle time was to include games or other opportunities to further work in these areas. Art and cooking projects were not abandoned, but free play time had to be shortened.

In practice, the reading activities were successfully conducted by the head teacher in her group

sessions and fully supported throughout the day by the rest of the staff. This was not the case with mathematics. Plans to start small-group work in this area were postponed for months while the staff looked for suitable materials and a guide that would aid implementation without demanding elaborate day-to-day preparation. None of the teachers had had any experience in early childhood mathematics in centers where they worked before. Although children had many opportunities to play with materials that embody mathematical concepts, teachers rarely encouraged or supported concept exploration with questioning or other techniques.

Since no observations were conducted or records kept on each child's interest and level of participation in activities that may convey mathematical ideas, there were no provisions to incorporate and stimulate mathematical exploration in the case of children who did not choose to participate spontaneously. This state of affairs was in sharp contrast to the expressed goal of the center which was to enhance all children's mathematical skills in a developmentally appropriate way.

This practicum addressed the problem of inadequate teacher preparation in the areas of learning theory, content, and methodology as it related to mathematical instruction for young children.

B. Evidence of the Problem

In order to assess the need for improvement of the mathematical component of this particular child care center, the writer conducted a survey of parents' opinions about their children's mathematical learning at school and at home. The parents of all twenty-six children were asked to fill out a questionnaire (Appendix A). In the case of two-parent families both parents were expected to respond. Twenty-five responses were obtained representing parents of twenty-four children. Overwhelmingly (twenty-three) parents thought children needed more planned math activities. Parents also wanted to be informed of the learning experiences at school and requested suggestions on how to reinforce mathematical learning with activities at home. Parents were unsure about the adequacy of informal incidental learning: twelve responded that they did not know if children learned enough mathematics incidentally, while nine said that informal learning was not enough.

Parents' own teaching of mathematics seemed to cover a surprisingly wide range of concepts: counting, addition and subtraction, classification and seriation, shapes and solids, problem solving, and practice in patterning were checked by most (twenty-one) parents. A majority said that they also taught their children how to tell time

and the value of the different coins. Some parents also checked multiplication (five), division (seven), and fractions (seven).

Concerning the best ways of teaching mathematical ideas, parents chose guided discovery (fourteen) and free play (ten) as the most appropriate methods. Only one parent considered workbooks and paper-and-pencil tasks as the preferred approach.

A majority of parents described their child as "interested" to "very interested" in mathematics. Opinion was divided as to the usefulness of the computer in the teaching of mathematics in the preschool. Eleven parents thought it could be useful, while seven believed it should be introduced at the kindergarten level or later; seven were undecided.

In light of the interest expressed by the center's parents to see more planning in the area of mathematics, the writer wished to find out how centers of comparable size, population, and organization were implementing the mathematics curriculum. A telephone survey of ten private child care centers showed that all emphasize mathematical learning to the same degree that they do language and reading activities. All centers believe in the importance of carefully selected materials that embody mathematical concepts. Teachers at these centers took advantage of

many opportunities (circle time, cooking, free play) throughout the day to explore and verbalize mathematical concepts. In addition, six centers conducted structured regular "math time" from twice a week to five time a week. In all instances, these group sessions were the responsibility of one specific teacher at each center.

Early childhood mathematics does not seem to be an area of expected expertise for all teachers. Three of the six teachers who conduct regular math sessions said that they based their planning on Baratta-Lorton (1976), a kindergarten-first grade textbook inspired by Piagetian research. In all cases, teachers acquired their mathematical expertise individually without the aid of formal courses. None of the centers interviewed conducted any form of staff development program in mathematics nor did they own or use a commercial mathematics kit. All the directors or head teachers interviewed said that they considered mathematics a very important part of the curriculum and that they were presenting more mathematical activities now than in the past. Two directors said that they were upgrading the program by buying more mathematical learning materials.

In contrast to these findings, an observation of this center's daily activities showed that there was no planned time for mathematical learning. Teachers offered verbal

support only in the area of whole numbers, more particularly drilling and testing children's rote counting skills. The calendar, and, less often, cooking projects were the only times when teachers structured and stimulated mathematical exploration. Although the center was well-equipped with materials such as Cuisenaire rods, Montessori cylinders, classification games, pattern blocks, Unifix cubes, geometric shapes, and attribute blocks, teachers rarely used them to encourage conceptual development.

A teacher's questionnaire (Appendix B) confirmed the sporadic attention that mathematical learning received in this child care center. According to the responses, none of the teachers had ever planned structured activities that dealt with the main concepts of early childhood mathematics. Teachers seemed to prefer an informal exploration of number, classification, and seriation in the context of children's spontaneous play. However, even these teaching episodes occurred only occasionally.

These findings were consistent with the maturationist view of early childhood education which characterized this center until recently. The maturationist teacher provides a nurturing setting, a wide variety of experiences, and guidance and support while the child interacts with the environment. It is for this role that teachers are prepared by training and experience (Sunal, 1982). The

adoption of the cognitive-transactional approach by this center resulted in new demands for the teacher. It emphasized the role of the teacher in consolidating and extending the children's acquisition of mathematical concepts, and it required him/her to design interesting and challenging activities that will stimulate progression in specific developmental areas (Sunal, 1982). The questionnaire showed the teachers' interest in knowing more about the stages of children's cognitive development, particularly as it related to the acquisition of mathematical concepts. At the same time, teachers expressed their need for suggestions on how to encourage mathematical ideas in order to be able to fulfill their new demanding role.

The need to increase teachers' confidence in the area of mathematics at the early childhood level was further supported by research findings concerning the function of language and the role of the adult in the process of concept acquisition. Many early childhood education programs, especially those following the traditional nursery school model, subscribe to the view that systematic mathematical instruction is unnecessary since children will acquire these concepts incidentally through informal contact and play with educational materials and through real experiences in daily life. Although many teachers have

been aware of the developmental process of building mathematical understanding, they limited their observations to the acquisition of counting skills. In consequence, it is not unusual to find that work with whole numbers comprises the entire mathematics curriculum in traditional preschool settings.

The advent of compensatory education created a new interest in early academic instruction, and mathematics for young children became a subject for curricular design and experimentation. Arithmetic and geometry were introduced at the pre-kindergarten level. Different instructional methods were tried from the drill-and-practice approach with the teacher in the central role (Engelman & Carnine, 1970) to the concrete exploratory method in which the child is given the opportunity to learn through play (Nimnicht, 1969). Although no consensus has been reached on which instructional method is the most effective, cognitively-oriented programs for young children agree that early mathematical experiences contribute to a better understanding of mathematical abstractions later on during the elementary school years.

The work of Jean Piaget has been another powerful influence in mathematics instruction in spite of the ongoing debate about the precise nature, validity, and instructional implications of his theory. Piagetian

findings have been incorporated into programs whose goal is to support the development of broad intellectual power rather than the attainment of narrow academic skills. Piaget postulates that mathematical knowledge cannot be taught. It has to be constructed by the learner through active involvement with the environment (Gibb & Castenada, 1975). The popularization of Piagetian thought has had a twofold effect on early childhood mathematics. It made the teaching of young children intellectually more demanding due to the importance attributed by Piaget to reflective abstraction characteristic of logico-mathematical knowledge as the basis for the empirical abstraction of physical and social knowledge (Kamii, 1982). At the same time, Piagetian theory deemphasized the role of the teacher. Since this perspective claimed that children construct concepts spontaneously as they interact with the environment, teachers tend to refrain from explicitly presenting the concepts hidden within the objects, materials, games, activities, and social stimulations that are offered to the child (Barbour Benham, Hosticka, Payne, & Yeotis, 1982). Piaget wrote that, "It is a great mistake to suppose that a child acquires the notion of number and other mathematical concepts just from teaching. On the contrary, to a remarkable degree he develops them himself independently and spontaneously" (quotes in Copeland,

1970, p. 57). Thus, for Piaget, the child alone, interacting with objects and with his peers, constituted the paradigmatic learning situation.

Recent studies in mathematics education have sought to extend and refine Piaget's theory. Fuson (1980) turned to Vygotsky for a very different view of concept acquisition. For Vygotsky, the child did not just "develop" spontaneously and unconstrained but is "developed by" her social and cultural context and especially by the older members of that context. In contrast to Piaget, Vygotsky saw the paradigmatic learning situation as one in which the child interacted with an adult. The adult fulfilled a directive function that takes into consideration the child's attention, actions, and psychological functioning. The adult provided verbal information about concepts or action sequence and furnished the child with the cultural and intellectual tools and the help to use them.

Although verbalization in mathematical learning has become suspect during the last twenty years of curricular development due to the fears of producing premature and empty verbalism in young children, language has been found to play an important role in concept acquisition. Verbal support may not only provide information, it may also involve the organizational understanding of a task. Steffe and Smock (1975) studied the effects of language

in the growth of mathematical concepts. They concluded that for children in the preoperational stage, any attempt to teach mathematical concepts solely through verbal or symbolic means will be unsuccessful. However, since words and symbols are an important part of mathematics, a carefully arranged balance between the spoken word and concrete actions should be maintained. More recently, Siegel (1982) studied the development of quantity concepts and found that although verbal cues did not facilitate learning in very young children, language did play an increasing role in the case of children four years old and older.

The preceding findings pointed to the need to relate the different modes of teaching mathematics to a continuum of levels of verbal support. Discovery learning will be accomplished with a minimal level of language support while didactic teaching will be characterized by an almost total reliance on language as the instructional tool. Often these modes are posed as the only alternatives, while the whole range of levels in between is ignored. Fuson (1980) pointed out that Vygotsky's ideas ought to help teachers steer clear of two naive alternatives: an overemphasis on children's developmental stages or an overemphasis on the content the adult wants to teach. The first choice dictated that the teacher has to wait for the child to become concrete

operational in order to work with number concepts. The second choice disregarded the complex relationship between development and learning.

The instructional implications of the revisions of Piagetian theory are listed by Barbour Benham, Hosticka, Payne, and Yeotis (1982). In order to assure that conceptual learning takes place, the following steps have to be taken:

- The teacher will design structured interactions between child, adult, and materials in order to highlight the mathematical concepts which may be hidden in the informal curriculum of early childhood education.
- The teacher will consciously plan activities with language reinforcement which invite the child to attend rationally to the concepts being explored.
- The teacher will plan structured activities in order to enhance self-correction and tolerance for incorrect responses as well as correct ones.

In summary, teachers of young children should help focus, not dictate, the learner's attempt to give structure to what is observed. In this theoretical context, teachers are expected to play an important role in the area of early childhood mathematics for which they are not necessarily prepared.

C. Cause of the Problem

Although research shows the importance of early mathematical

learning, parents want more planned mathematical activities for their children, and many centers implement structured mathematical curricula, early mathematical experiences were not offered in this child care center in a systematic and planned manner. This situation was caused by the staff's lack of training and experience in this area of the curriculum. The teacher questionnaire showed that teachers did not feel competent to teach mathematics to young children. In consequence, they avoided this topic and planned activities in art, science, language, and reading instead.

This low level of mathematical confidence and expertise was not unique to the staff of this particular program. Most of the teachers who work in the Oakland area have been trained at Merritt College, a community college that offers a program leading to the California Children's Center Permit. A review of the courses for early childhood education majors offered during the last five years revealed that no course was presented on the development and teaching of early childhood mathematics. At the same time many courses were offered in the curriculum areas of art, literature, music, and science for the young child.

Traditionally, students enrolled in early childhood teacher training programs are not mathematically inclined and may experience feelings of math anxiety (Fennell, 1982).

Fennell recommended that teacher preparation programs acknowledge this fact and assist the students in developing confidence and competence in mathematics. This would insure an appropriate level of interest and enthusiasm for presenting activities in mathematics in early childhood settings.

D. Review of the Literature

The work of Jean Piaget and the school of Geneva constitute the point of departure of modern studies on mathematical concept acquisition and the function and importance of mathematics education. According to Piagetian theory, the main key to the child's mental growth is the paramount part played by the child's own actions and the way these actions turn into an inward process of the construction of cognitive structures (Piaget & Szeminska, 1941). Piaget demonstrated through test situations what it takes for children to acquire the real meaning of number, a concept that cannot be taught or its acquisition hastened by adult intervention. In a later work, Piaget (1969) examined the instructional implications of his theory. He saw the role of the teacher as that of a guide. Adults should allow children to form their own ideas rather than prematurely imposing ready-made thought on them. Furthermore, they should wait until children become concrete

operational before introducing them to mathematical formalism.

Copeland (1970) further explained and explored Piaget's ideas in order to make them accessible to teachers of elementary school mathematics. Copeland's interpretation emphasized Piaget's distrust of language as a facilitator in the process of mathematical concept acquisition. He also reiterated the Piagetian idea that formal instruction about numbers should be deferred until children reach the age of six-and-a-half or seven.

As a consequence of the intense interest in Piagetian theory during the 1960s and 1970s, logico-mathematical cognition was the area of cognitive-developmental research that received the greatest attention. Within this area, topics related to number development seem to be the most active subdiscipline. Since so much of the school curriculum is devoted to transmitting basic numerical skills, the popularity of number development research is hardly surprising. This research has raised many questions about Piaget's fundamental assumption, most importantly about his concept of conservation-nonconservation (Acredolo, 1982). A revision of Piagetian theory cannot but have profound instructional repercussions.

The National Council of Teachers of Mathematics (NCTM) has promoted an active dialog between psychologists and

mathematics educators through conferences and the publication of relevant research. Among these publications is the collection of studies edited by Rosskopf, Steffe, and Taback (1971) dealing with the implications of Piagetian theory for mathematical education. Several authors in this volume took issue with the findings of the Genevans, especially Beilin (1971) who studied the role of language in the acquisition of logical operations and found Piaget's disregard of the linguistic context to be a serious shortcoming of his theory. Steffe (1975) edited another collection of research for NCTM on mathematical thinking of young children. This research was conducted to test for possible relationships between the cognitive systems of the child and knowledge of the system of mathematics. Cognitive-developmental theory can contribute to an understanding of how it is a child acquires mathematical knowledge, but research has to study also those cognitive operations demanded by mathematics and which may be distinguishable from operations described in Piagetian theory. The conclusion drawn from these studies was that mathematics education, especially in the early years, requires widely based but directed programs, involving both action and language in small-group work.

Ginsburg (1977) also considered Piaget as the starting point of his research, but his conclusions emphasized the

great intellectual accomplishments of preschool children. He observed the development of young children's spontaneous arithmetic and discovered the importance of early counting skills in the development of the number concept. Ginsburg's guidelines for early childhood mathematics teaching achieved a balance between verbal instruction and the fostering of spontaneous growth.

Brainerd (1979) reexamined Piaget's concept of number on a theoretical level. He studied the origin of the number concept and disagreed with Piaget's understanding of number as a combination of the relational and the classificatory. Brainerd affirmed that number is not at the same time ordinal and cardinal, but that these aspects are separate and are acquired by children at different stages of their development. Since a child learns ordination much earlier than true cardination, according to brainerd, mathematics education should be based on the logic of relations instead of the logic of class.

Gelman and Gallistel (1978) studied the nature and design of the Piagetian tasks. They found that often the difficulties encountered by the young child did not lie in the complexity of the concept, but that they were caused by the design of the task. In consequence, Piaget underestimated the cognitive capacity of the preschooler. Gelman and Gallistel (1978) showed, in contradiction to Piagetian

theory, that young children indeed share some of the adult's notion about number, especially if small numerosities are concerned. These authors, like Ginsburg (1977), emphasized the importance of early counting as the foundation for arithmetic. In a recent article, Gelman (1980) reported that counting skills in two- to five-year-olds is related to the ability to reason numerically. She concluded that Piagetian conservation tasks underestimated the young child's operational understanding of number. These findings refuted the commonplace assumption about the futility of trying to teach arithmetic before a child succeeds in the conservation tasks. At the same time, Gelman reminded the teacher of the importance of gearing instruction to the child's level of cognitive development, but she also pointed out that not enough is known about what young children can and cannot do.

Steffe (1980) also demonstrated the importance of counting in the early learning of mathematics. He pointed out that Piaget did not include a theory of counting as a part of his theory of number. Steffe studied three modes of counting: rote counting, point counting, and rational counting in their role in the solving of addition and subtraction problems. In conclusion, he noted the need for a study of the development of children's counting and a further elucidation of its relation to addition and

subtraction. Such a study would result in new instructional strategies for the teacher of young children.

School Science and Mathematics dedicated its January 1982 issue to the importance of teaching mathematics and science in early childhood education programs. Barbour Benham, et al. (1982) stated that conceptual learning could be enhanced in mathematics at the early childhood level. In order to achieve this goal, teachers will carefully structure activities to incorporate materials and language to focus on the concepts in an interactive way. Fennell (1982) examined the complexities of early childhood teacher preparation and specifically the mathematical background needed to promote interest and enthusiasm in teaching mathematics to young children. The author addressed three areas of concern: content, learning theory, and methods as they relate to early childhood mathematics. These concerns needed to be explored, not only during initial training, but also in later staff development activities in order to meet pupil needs in mathematics.

CHAPTER THREE

Anticipated Outcomes and Evaluation Instruments

A. Statement of General Goals

The general goal of this practicum was to plan, implement, and evaluate a staff development program in order to increase teacher competency in the area of mathematics for young children. It was hoped that a greater understanding of mathematical content, teaching strategies, and children's cognitive development would promote interest and enthusiasm in teaching early childhood mathematics. Furthermore, it was expected that competency would result in a planned and systematic implementation of mathematical experiences for the children of this center, both in a formal and informal context.

B. Behaviors Expected, Assessment Instruments, and Standards of Performance

The following objectives were projected for this practicum.

After the period of implementation:

1. a. teachers will be able to define relevant mathematical concepts in relationship to children's cognitive development (Appendix C),

b. teachers will be able to design at least two planned activities for each concept,

c. teachers will be able to name at least three incidental (informal) learning opportunities for each concept,

d. teachers will experience increased interest and enthusiasm in teaching mathematics to young children.

2. a. each teacher will have presented one weekly fifteen-minute mathematical activity in a small group of four to six children for eight weeks,

b. teachers will have communicated to the parents on a biweekly basis the mathematical concepts that have been explored. Teachers will have offered suggestions for at least one activity for each concept that parents could do with their child at home to extend and reinforce mathematical learning.

Assessment Instruments and Standards of Performance

Objective 1 (a, b, and c) was measured by a written test designed by the writer (Appendix D). A score of 75 percent of answers correct by an individual was the criterion for individual success. All participants were expected to obtain that score in order to consider

that Objective 1 (a, b, and c) had been reached.

Objective 1 d. was documented by the staff's answers to statements that the participation in this staff development program increased their interest and confidence in teaching mathematics to young children. These statements were included in the second teacher questionnaire (Appendix E) as Items 4, 5, and 8. Three out of four positive responses to each item was considered to indicate success.

Objective 2 a. was documented by the observation and recording of activities in a weekly log during the eight weeks of that phase of the implementation. Success was considered to be achieved if each teacher presented six small-group mathematical activities (out of a possible total of eight).

Objective 2 b. was measured through the administration of a parent questionnaire (Appendix F). A positive evaluation required 80 percent of the respondents to report that they were more aware of the content of the mathematics program (Item 2 on the Parent Questionnaire #2, Appendix F).

Since teacher training was the strategy selected for this practicum to improve the mathematics curriculum, it was considered important to obtain the participants' opinions

on the effectiveness of this approach. Therefore, the staff development materials and the format of the program itself were evaluated by the teachers by means of a questionnaire prepared by the writer (Appendix E).

C. Possible Positive and Negative Side Effects

The implementation of a staff development program in order to increase teachers' mathematical expertise and confidence could have several side effects. Both positive and negative unintended effects on children, parents, and teachers were anticipated.

Among the positive side effects expected was the ability on the part of the teachers to incorporate mathematical concepts into their daily lessons. The program was also expected to increase teacher awareness of the nature of children's cognitive processes related to nonmathematical situations such as social interactions, language development, or the acquisition of scientific concepts. Further positive effects included an increased understanding of the cognitive characteristics (learning style, developmental level and aptitude, attention span) of each child and a greater degree of interaction with each child as an individual.

Furthermore, this program was expected to have positive side effects for the parents and their children. Suggested

mathematical activites and games carried out at home could also provide new avenues of communication and interaction between parent and child. Furthermore, parents might become more interested in their children't daily activities at the center. Increased awareness might result in a more active parent participation, better parent-teacher communication, and a greater understanding of the center's curriculum.

Among the possible negative side effects, the added work required by the participation in this program and the preparation of lessons could have proven overwhelming for the participants. The teachers might fear exposing themselves as weak (to this writer and to others on the staff) and experience anxiety about their performance during the actual work with the children and during the final test.

The possible negative side effects on the children would have to be carefully monitored. Care would have to be exercised to gear the mathematical experiences to the level of children's interests and cognitive abilities, taking into account at the same time their affective needs.

D. Description of Evaluation Instruments

The assessment instruments needed to evaluate the degree of success of the staff development program were designed by the writer. Several aspects of the implementation

were scrutinized. The teachers were evaluated on their theoretical understanding of mathematical concepts for the early years and the possible and appropriate teaching strategies. Their teaching performance was observed as well as their degree of success in involving parents as partners in the mathematical learning experience. Finally, the staff was asked to evaluate the in-service process itself.

A written test (Appendix D) was used to assess the participants' understanding of mathematical concepts as they relate to the child's cognitive growth. The test also asked teachers to propose materials and activities that would enhance a given concept and to demonstrate their awareness of the learning opportunities hidden in children's spontaneous play and implicit in the various daily activities and routines. Two hours were allowed for completion of this test.

Parent involvement in children's mathematical learning was an important factor in an early mathematics program. It was the responsibility of knowledgeable teachers to elicit parent interest and participation. The degree of this involvement was assessed by means of a questionnaire (Appendix F). Its questiosn inquired about the parents' awareness of the existence and content of a mathematical program for their children as well as parents' opinions

about the quality of the information they received from the staff. Parents were also asked if the suggestions for activities were interesting, practical, and if they resulted in mathematical explorations at home. Furthermore, they were asked for suggestions on how to improve the mathematics program.

The staff development program and materials (Teacher's Handbook and Activity File) were evaluated by the participants by means of a questionnaire (Appendix E). It assessed the Handbook as to the usefulness of the information presented and the applicability of the suggestions for action. Several questions provided an opportunity for feedback on the format and content of the Activity File, the teachers' intention to expand the Handbook and the File in the future, and the effect of teaching practice in small-group sessions on teacher confidence in the area of early childhood mathematics.

A detailed log documented the formal (small-group) mathematical experiences. The writer and the participants recorded each session, name of the teacher, the concept presented, number of participating children, duration, and a description of the lesson. Any informal (incidental) mathematical learning eposide observed by the writer was also recorded.

CHAPTER FOUR

Solution Strategy

A. Discussion and Evaluation of Possible Solutions

An increased interest in the early attainment of intellectual and academic skills has been expressed by educators, researchers, and parents alike. As a consequence of this concern, many early childhood settings are re-examining the content and pedagogy of their curricula. Traditionally, early childhood mathematics has been relatively neglected in the child care center and, at the same time, teachers have not been adequately prepared to enhance the development of mathematical concepts in young children. Thus, the administrator faced with the need to improve the mathematics curriculum will discover that increasing teacher competency is the necessary starting point.

Implementing a new mathematics curriculum or improving an existing one may seem just a question of what commercial mathematics kit to buy. On closer examination, however, this solution, although it is the easiest one, does not insure effective implementation. Kits share the characteristics of all "teacher-proof" curricula. Teachers do not like the prescriptive nature of most manuals that accompany these kits. They tell what to do and how to present it

they neglect to take into account the individual differences of teachers and children. Commercial kits offer only a limited variety of manipulative materials, ignoring the need for a direct experience with many different objects, environmental or teacher-made, in addition to acquired materials. The teacher's role is limited to that of a user of a product. Most importantly, this solution does not increase the teacher's understanding of mathematics or the child's processes of concept formation.

Another option for the administrator is to decide on the implementation of an accepted theoretical curricular model. These models provide plans and materials for preservice and in-service teacher training. The question in this case is if these training options are available to teachers in independent centers with limited resources and small staff numbers.

Among all the curricular models, the Montessori method has the longest tradition in mathematics instruction. This aspect of the curriculum, however, is embedded in the total program to such a degree that it is inseparable. This does not mean that certain features and especially certain materials cannot be incorporated into a creative independent setting.

Another early education model that focuses on mathematics is the DISTAR arithmetic program developed by Engelman

and Carnine (1970) as a derivation of the Bereiter and Engelman (1966) model of the academic preschool. The goal of this approach is to develop academic skills in young children through the attainment of a limited set of objectives. The lessons are based on a thorough analysis of the skills necessary to achieve the next step in learning. The implementation of the DISTAR program requires a willingness to adhere strictly to the prescribed techniques disregarding all other approaches. Teachers follow the Teacher's Guide to the word. Each lesson is presented as a script in regular type with stage directions in italics. Suggestions for eliciting group and individual responses are provided. These suggestions are precise and often include a prescribed treatment for difficulties exhibited by the learner.

DISTAR minimizes the need for trained teachers. Bereiter and Engelman (1966) even discouraged employing early childhood teachers in their program. Untrained adults can be easily prepared for teaching by memorizing and practicing the script. It offered a fast and inexpensive way of implementing a program that has been found to be successful in helping young children acquire arithmetic skills (Osborne and Nibbelink, 1975).

The disadvantage of this approach lies both in the theory that determines the program and in the teacher training

methods. Learning is based on the correct transmittal of established and uniform skills using language as the exclusive instructional medium with no regard for individual learning and teaching styles. DISTAR offers little opportunity for exploration and play. Manipulation of concrete objects is not considered necessary. Mathematics is limited to arithmetic and it is viewed as an abstraction or language, a view that may be too limited to establish early in a child's experience. Since teachers are seen as mere transmitters of facts, there is no room for the teacher's creativity nor are the affective needs of children and adults taken into consideration.

A very different idea of early childhood education underlies the High/Scope model based on Piagetian theory and refined through many years of experimentation (Hohman, Banet & Weikart, 1979). High/Scope represents an integrated approach in which the primary goal is to foster active learning on the part of the child. The curriculum is organized around "key experiences" designed to provide the teacher with an awareness of the basic intellectual processes on which the adult can build to enrich and expand any activity or experience. Teachers are expected to possess a solid early childhood education background. They are introduced to the specific High/Scope method through observation, summer workshops, and the perusal of the program's handbook. This

manual offers theory, ideas, and practical suggestions but still leaves considerable room for individual style and initiative (Hohman, et al., 1979). The High/Scope Foundation also developed audiovisual materials that may be used in workshops and in-service training. It is expected that the novice teacher will devote several years to the gradual acqusition of the cognitively oriented techniques.

The positive aspects of this model are many. An important one is the flexible approach to staff training since it may assume almost any form that the learner and the senior teacher decide upon. Another positive aspect is the basic philosophy of the High/Scope program which puts the learner, child or adult alike in charge of the learning process. This is reflected by the manual which establishes guidelines and offers suggestions that remains essentially seminal in nature. However, since the High/Scope curriculum is integrated, interweaving all fifty or so "key experiences," isolating the mathematical component would be impossible.

Another important curricular model, the Madison Project (Devaney & Thorn, 1974), provides in-service workshops taught by teachers already experienced in the Project's method or by way of a packaged course. Both options require approximately fifteen one- to two-hour sessions. The course starts "math illiterate" teachers on some mathematics using

the same lessons and games designed to teach the children. At the same time, it introduces active learning methods by asking the teachers to experiment with manipulative materials. The Madison Project was designed with the teacher as the most important element in the fostering of mathematical interest, creativity, and discovery. Ready-to-use materials by themselves would not bring about the desired changes (Howson, Keitel & Kilpatrick, 1981).

Another approach to staff development is exemplified by the Nuffield Mathematical Project. Its goal was to broaden the content of the mathematics taught at the elementary school level. It provided information to the teachers in a series of Guides. Since this project was developed for the British schools, the Nuffield Guides were based on the existence of Teachers' Centres and mathematics consultants who would help teachers to adapt the particular Nuffield guidelines to each specific classroom situation.

The Early Mathematical Experiences Project was developed in England as a derivation of the Nuffield Mathematics Project. Its developers identified the need to help very young children develop mathematical concepts through relevant experiences, activities, and conversations. The aim of the project was to study the relevant experiences and to help teachers with suggestions on how to foster mathematical learning. This help is provided in a book developed

by the project's directors and staff (Matthews & Matthews, 1982). The project also developed a slide pack and a videotape pack as in-service aids for trainers and advisors.

In-service instruction for the major curricular projects mentioned above varies in duration from a few weeks to several years of training. The instruction is usually delivered by external experts with the help of extensive audiovisual materials. This model is typically used in public education where larger staff numbers and greater financial resources make this kind of training possible. At the pre-kindergarten level, especially in small private child care centers, staff development occurs on a smaller scale and in a less formal way.

Early childhood teachers tend to achieve their professional growth through weekend workshops, evening classes, or through occasional conferences with or without the financial support from the employer. Some centers invite speakers to their site, especially if the staff is large enough to make this feasible. Other alternatives may follow the in-house model. They may take the form of orientations, staff meetings, or in-service workshops conducted by the center director or by an experienced teacher (Zappe, 1981).

A promising approach which is seldom mentioned although it has a high potential for success is the everyday on-the job training that can occur between the supervisor and the

child development personnel (Kostelnick, undated).

The advantages of both in-house and on-the-job staff development are many. The new strategies will focus on the specific problem areas familiar to all participants; suggested changes will take into account the needs of the children, attitudes of parents, and the limitations and strengths of the center's physical facilities. In this format continuous feedback can be provided to staff members about their progress and about methods of dealing with problems that arise in the learning process. Finally, dollars can be saved by using personnel to train workers while all are performing their regular jobs.

B. Description of and Justification for Solution Selected

The solution strategy selected in this practicum was based on an in-house and on-the-job staff development model. It aimed to increase teacher competency and self-confidence through a better understanding of the nature of early childhood mathematical concept acquisition and the implementation of activities to support the child's cognitive growth in this area. Suggestions were presented in order to help start the process of translating theory into the practice of stimulating children's mathematical thinking. It was hoped that the program would also develop teachers' skill in involving parents in the mathematical program.

The writer developed a Teacher Handbook (Young Children's Mathematics - A Handbook for Teachers in Child Care Centers and Preschools, Appendix G) which provided the teacher with basic information about the crucial early concepts and the developmental facts about the child's acquisition of each specific concept. It also offered examples of formal and informal opportunities to foster concept formation. The format of the manual was based on the co-authorship with the participant in order to arrive at a guide tailored to the needs and learning/ teaching style of each teacher. Participants were expected to complete each chapter by observing specific learning incidents and analyzing the classroom and the existing equipment. They were also asked to suggest additional materials and activities, in the light of the concept under discussion. The result was expected to be a personally relevant handbook that could be expanded with the teacher's own readings and experience and may be of continuous use as a guide and reference.

The writer also prepared an Activity File to assist teachers in the preparation of planned mathematical experiences. Far from trying to be complete or definitive, it was presented as a collection of suggestions. Teachers were asked to add comments about how to improve, change, or discard activities and were invited to expand the file with

new ideas for mathematical activities.

The materials for this practicum were based on recent research in mathematics learning and teaching in the area of early childhood. The following writings were particularly important. The NCTM dedicated one of its yearbooks to the teacher of young children between the ages of three and eight (Payne, 1975). This yearbook was designed to offer help in the making of important decisions about teaching and curriculum planning, to be a source of theoretical knowledge and practical activities. The teacher is viewed as a planner of experiences which strike a balance between teacher direction and children's choice. Incidental experiences are part of the learning process but these are not to be relied upon as the only learning opportunities. The Early Mathematical Experiences guide (Matthews & Matthews, 1982) presents the relevant experiences that lead to mathematical ideas in children ages three to five. The authors adopt an eclectic view of the role of the adult. The teacher needs to give careful thought to the mathematics inherent in any activity or material offered to children. Then, if the child shows a particular interest, she can be guided towards the mathematic idea and the language that goes with it. Young children need to be "doing and thinking" while the adults provide challenging conversation to help them put these

thoughts into words.

A book written primarily for parents by Green and Laxon (1978) provided interesting ideas for challenging activities. The authors subscribe to Piagetian theory; their goal is to enable the adult to help children develop number concepts in an informal manner. To achieve this the authors ask the readers to deal with their own math anxiety first and then to understand the gradual nature of the development of number concepts in young children. Learning proceeds through a logical network of verbal, perceptual, and manipulative skills. These skills are related to ideas such as identity, fit, belongingness, matching, mapping, size, and quantity, all of which have to be integrated before true mathematical thinking can emerge.

The importance of early mathematical experiences as the basis for future success in mathematics is also emphasized by Barron (1979) in her book addressed to the teachers of young children from preschool through third grade. They are challenged to consider the research of Piaget, Gagne', and Bruner in order to structure a classroom environment that reflects an understanding of children's levels of intellectual growth. The author also offers a wealth of practical suggestions without omitting the needs of exceptional children.

Another useful guide well-founded on theory and research has been authored by Cruiskshand, Fitzgerald and Jensen (1980). Learning is understood as the interaction between adults and children; the quality of learning depends on the quality of this interaction. The authors deal with topics such as learning styles, the affective factor, the integration of mathematics into the general curriculum. This work abounds in suggestions for activities, available materials, both environmental and commercial, and in ideas to extend the teacher's own learning.

On a less ambitious note, Maffei and Buckley (1980) provide the teacher with mathematical activities introduced by short paragraphs describing the concept underlying the activity. The teaching strategy is influenced by Piaget's concept of the pre-operational child and results in an approach that is somewhere between a structured and a non-structured one, one in which the adult guides the child towards constructing his own knowledge.

A similar approach is adopted by Brown (1982). This book was a rich source of mathematical activities. Suggestions for games and original teacher-made materials were incorporated following the ideas and directions of Baratta-Lorton (1979). More logic and mathematical games for young children were found in an older work by Holt and Dienes (1973) along with valuable ideas on how to

combine play and learning.

The theoretical foundation for the autonomous development of the individual, child and teacher alike, was presented with clarity and conciseness by Kamii (1982) in a short work on the teaching of number in early education settings. Although mathematical ideas cannot be taught directly, the role of the teacher is more active than generally assumed in strict Piagetian terms. Kamii assigned the teacher the crucial role of encouraging intellectual autonomy in children in order to develop such values as love of learning and self-discipline. She considered early childhood mathematics as an excellent area in which to practice these teaching skills.

The advantages of the chosen strategy for this practicum were not limited to is low cost and its feasibility. New staff can be trained at any date in the future using the materials developed in this practicum complemented by the on-the-job guidance provided by the more experienced teachers. Furthermore, the strategy provided for the involvement of all the staff members in the in-service program. This was expected to result in activities and conversations that would permeate the curriculum with mathematical awareness.

In addition to the mentioned advantages, the chosen solution followed the basic principles of in-service

education enumerated by Katz (1979):

- The program focused on helping teachers develop understandings that are more appropriate, more accurate, and deeper than they had been by extending their constructions and assumptions about how children learn and about how adults affect that learning process. This increased understanding is expected to stay with the teacher and will be of use after the in-service program is over.
- The program asked the participants to contribute their own insights, observations, and previous experiences. It organized information without being prescriptive. The program was expected to strengthen the participants' disposition to go on learning and to continue to be inventive without becoming dependent on the specifics of the program.
- As a result of the increased understanding, teachers were expected to experience a higher degree of confidence that would enable them to use their existing and newly acquired skills more effectively.

In order to provide mathematical instruction during the transitional phase of practicum preparation and implementation, this writer decided to begin regularly scheduled small-group work in mathematics. The center's teachers were invited to observe and encouraged to teach one or more

sessions themselves. During the four months the small-group work has been in operation, teachers have participated regularly in these "math times" but they have not felt confident enough to take charge of the lessons themselves. They felt that they were not familiar enough with the mathematical materials and the appropriate teaching strategies.

C. Report of Action Taken

The first part of the implementation of this practicum consisted in the preparation of the staff development materials: The Teacher's Handbook, Activity File, and the evaluation materials (Appendices D, E, F, G, and H). If a reader wished to implement this in-service training program, these materials may be used as written or with only minor revisions to adapt them to the particular circumstances of the center where the materials would be applied. Most centers, on the other hand, will prefer to develop their own evaluation criteria or may decide not to use evaluation materials at all.

After the completion of the Teacher's Handbook and the Activity File, these materials were introduced to the participating teachers at a two-hour meeting. The self-study format was explained, suggestions on how to proceed through the program were offered, and questions were answered. Each participant was given a copy of the Handbook and this writer presented a short overview of the mathematical

concepts on which the program is based. Later, other resources were introduced such as books on early childhood mathematics, school supply catalogs, and mathematical games and materials. This initial meeting was brought to a conclusion by actual play and role playing with the Attribute Blocks, followed by brainstorming of possible activities for young children around this apparatus. At the time of this first meeting, a fourth participant joined the three teachers who regularly work at this center. This teacher, a regular substitute who was already a familiar presence for the children, agreed to spend three mornings a week at the center during the twelve weeks of implementation.

During the first meeting it was decided that the participants would meet individually with the writer at least once a week to discuss their progress in completing the Handbook and ask any questions that the teachers might have. In practice, the meetings were more frequent given the close working relationship between the writer and the participants. Very often a teacher would ask for a demonstration of activities with a specific mathematical apparatus. On other occasions, the observation of spontaneous mathematical behavior in a child or a group of children would elicit a request for clarification of the mathematical concept involved. These frequent informal meetings and conversations continued during the first four

weeks while teachers were working on their Handbooks, and beyond, during the entire period of implementation.

The teaching practice with small groups of four to six children began in the second month of implementation. The participants were given the choice of working with the same group of children throughout the eight weeks remaining or to alternate among the different "math" groups. These groups had been established by the writer by grouping children approximately by age and interest in mathematics. The teachers elected to work with the same group of children throughout their teaching practice.

The participants were free to choose the subject of each small group session. Each teacher was asked to record briefly the date and duration of each session, the concept explored, and the materials used. The teaching sessions were observed by the writer and, on occasions, also by one of the other participants.

During the weeks of their work with the children in "math" groups, the participants were expected to talk to parents about the center's mathematics program, particularly to those parents whose children were in the teacher's own group. The teacher was expected to comment on the mathematical concept(s) she was exploring and about each child's interest in and reactions to the activities presented. These conversations were expected to happen frequently but informally. The verbal aspect of parent-teacher

communication took place as planned, although most of the conversations happened with those parents who were already very interested in their child's cognitive growth. The teachers reported limited success in reaching those parents who are more reluctant to discuss their children's development.

In addition to verbal communications, the participants were asked to prepare four written notes each directed to the parents offering suggestions for mathematical activities. These "Math Notes" were to be displayed weekly on a special "math" bulletin board. Although the writer provided models for these notes, this aspect of the practicum proved to be the most difficult for the participants.

After the eight weeks of teaching practice and before the administration of the written test, the teachers asked for an additional week in order to review the Teacher's Handbook. This extra time was allowed and, once elapsed, the Written Test (Appendix D) and the Teacher Questionnaire #2 (Appendix E) were administered. At the same time, parents were asked to complete the Parent Questionnaire #2 (Appendix F).

Throughout the weeks of implementation the writer was available to the participating teachers in the multiple role of a resource person, an observer, and, finally, as an evaluator. Any duplication of this staff development program

will require the presence of a person prepared to act as a master teacher with at least an elementary knowledge of mathematics and a good understanding of how young children acquire mathematical knowledge. In practice, teachers' questions referred more often to a basic mathematical concept than to the developmental aspects of its acquisition by children. This fact reveals the severe deficit of mathematical knowledge in some of the adults who work with young children and confirmed again the need for this program.

CHAPTER FIVE

Results, Conclusions, and Recommendations

A. Presentation and Analysis of the Results

This practicum was designed to increase teacher competency in the area of early childhood mathematics by means of a staff development program. It was anticipated that a better understanding of basic mathematical concepts, appropriate teaching methods, and cognitive development would result in greater teacher interest and skill in providing young children with mathematical experiences in a formal as well as informal manner. Teachers were also expected to increase their ability to involve parents in the mathematical cognitive development of their children.

To determine whether or not there was an increased understanding of the facts related to the implementation of a mathematics program in an early childhood setting, the participating teachers were asked to take a written test (Appendix D). The test scores obtained show a remarkable level of achievement in three out of the four participants who ranged from 92 to 95 points out of a possible 100. The fourth participant scored 32 points, a low result that can be partially attributed to her difficulty in answering essay questions.

The results of the written test were supplemented by

the examination of the teachers' work in completing the Handbook and the observation of the small group mathematics sessions. All participants completed the Handbook to the required extent while two also worked on the optional section Extending Yourself. Teachers consulted all the available resources, books, school supply catalogs, and the Activity File. They also visited the library several times to examine books for children and to search for new ideas for "math" group activities.

Two of the participants experienced considerable difficulty in understanding the basic mathematical concepts and required extensive work in such areas as cardinal-ordinal numbers, classification, and geometrical shapes. One of these teachers was able to acquire the needed knowledge within the framework of the staff development program.

The observation of teaching practice in small group sessions yielded very encouraging results. All four participants presented eight sessions each out of a possible total of eight. The duration of each session ranged from a short ten minutes to a maximum of forty-five minutes. The teachers appeared well-prepared and presented varied activities touching many concepts. Most activities were creatively planned and greatly enjoyed by the children. Very often the materials used were environmental

objects (corks, spools, pebbles, rice) or teacher-made games. Only occasionally would teachers use such materials as the Cuisenaire rods or the attribute blocks.

The observation of daily and routine interactions between teachers and children revealed an increased awareness on the adults' part of the opportunities for mathematical learning. Circle time, snack time, and block and sand play were the most fertile settings for extending and sustaining teacher behaviors.

The task of communicating the nature of the mathematics program to the parents and of enlisting their collaboration in reinforcing the concepts explored during the small group "math" sessions at the center proved to be the most difficult aspect of the program. Three participants presented three Math Notes and only one wrote the required four. These suggestions and examples of mathematical activities parents could do with their children at home were posted on a special bulletin board. Although teachers took enthusiastically to the small group work and the nurturing of mathematical discovery in the context of children's play, they asked for considerable support in order to prepare the mentioned notes. Another indicator of the difficulties experienced by the teachers in this aspect of the implementation is that while participants continued presenting mathematical activities to small groups

of children after the staff education program was completed, they did not prepare any additional notes to the parents.

In spite of the difficulties the teachers experienced communicating with parents, parents enjoyed the increased feedback. Twenty-one completed Parent Questionnaire #2 (Appendix F) forms obtained from a total of twenty-one families representing twenty-six children. All respondents were aware that their children participated regularly in a planned early childhood mathematics program. Fourteen respondents were more aware of the content of "math time" since all teachers participated in the staff education program. The notes posted on the bulletin board helped twenty parents and nineteen respondents found the activities appropriate, interesting and fun. Twelve families followed the suggestions for activities and played mathematical games with their children three or more times, seven played once or twice, while two families never followed the suggestions.

Personal communications between teacher and parent were not as successful as the posted "math notes." Fourteen respondents reported that a teacher had talked to them once or more than once about the mathematical activities their children had participated in, while seven said that teachers never informed them. Parent-teacher communication was also the prevalent subject of parents' written comments. Several

said that they would like more information about their children's progress on an ongoing basis. Many parents expressed their preference for a handout format for the "Math Notes" rather than posting them. Several parents asked for help with the mathematics involved while one person suggested a "workshop" parent meeting designed to familiarize parents with the materials and activities in a hands-on manner.

Although the 66 percent of parents aware of the content of the mathematics program falls short of the expected 80 percent, the participation of all the teachers has increased parent involvement significantly as demonstrated by the positive response to the "Math Notes." Future implementations of this practicum need to place great emphasis on this very effective way of eliciting parent involvement.

One of the basic objectives of the staff development program was to increase the participants' interest and enthusiasm in the teaching of mathematics to young children. This objective has been achieved to a remarkable degree at this time. It remains to be seen if the enthusiasm and sense of competency will last. In answer to the Teacher Questionnaire #2 (Appendix E), all participants commented that they had learned a lot. However, they all reported that they considered this only a beginning since the program

made them aware of how much more they need to learn to be fully effective in the area of early childhood mathematics. Nevertheless, all felt that the teaching practice had increased their confidence in planning and presenting mathematical activities. Also, all teachers liked the self-study format of the program and considered that the writer was always available for help when needed.

The materials developed especially for this practicum, the Hanbook (Appendix G) and the Activity File (Appendix H), were positively evaluated by the participants. They found the materials helped them to prepare for their respective "math groups." The work required to complete the Handbook was rated interesting and appropriate, although one participant commented that she found the Handbook too difficult at first. Asked for suggestions for improvement, one teacher said that she needed more help in how to communicate with parents both verbally and through notes or handouts. Another teacher felt that the staff development program should deal at greater length with the mathematical concepts themselves before exploring the developmental and methodological concerns.

B. Conclusions

An examination of the results of this practicum indicates that all the goals were achieved to a significant

degree. Three out of the four participants demonstrated an increased understanding of early childhood mathematical cognitive growth. All four teachers felt that they gained confidence and experience in the implementation of a mathematics program for young children.

The expectation that mathematical thinking would permeate the whole day at the child care center became a reality. All the teachers demonstrated an awareness of the mathematics hidden in the daily curriculum and are now able to focus and refine the children's spontaneous explorations. Teachers have also demonstrated skill and enthusiasm in leading regular mathematics sessions for groups of four to six children.

Although communicating with parents was the most difficult aspect of the program according to the participants, parents perceived their efforts as very successful. It was also found that many parents felt that they needed help and support in the area of children's mathematical concept acquisition. In consequence, the participating teachers decided to plan and present a workshop for parents at the beginning of the new school year in order to familiarize parents with the basic concepts explored throughout the program and to provide hands-on experience with the mathematical apparatus (Cuisenaire rods, attribute blocks, pattern blocks, graduated cylinders, among others).

Teachers are also exploring a way of providing regularly mathematical suggestions in the form of weekly handouts.

The self-study and on-the-job format selected for this staff development program proved to be very effective. The participants were, for the most part, able to complete the required work while working with the children. The availability of a master teacher, in this case the writer, contributed to make this an excellent way of delivering in-service teacher education. The program showed, however, that a reasonable knowledge of mathematics cannot be assumed to exist in all early childhood teachers.

The Teacher's Handbook and the Activity File, designed specifically for this practicum, were considered to be interesting and useful by the participants. These materials focused on the very young child providing the reader with information and ideas which are applicable in a preschool setting. The Handbook can be made more attractive if photographs and drawings of children involved in mathematical activities were included. A Subject Index would help make the use of the Handbook easier.

In addition to the anticipated positive effects, this practicum also produced some unintended positive side effects. As foreseen in Chapter Three, teachers gained a better understanding of children's cognitive achievements

in general while, at the same time, they become more knowledgeable about the mental and emotional development of those children participating in the teacher's particular group.

Another positive side effect was the parents' greater awareness of other planned activities (creative movement, music, reading) regularly scheduled at this center. Many parents also acquired the habit of inquiring periodically about their children's progress in all the areas of development. Furthermore, the teachers felt that they had become more skilled in reporting informally the daily occurrences at the center.

On the other hand, no negative unintended side effect was observed in relationship to the children. All teachers planned appropriate activities and sustained an open and noncompetitive atmosphere during the small group mathematics sessions. The teachers themselves, however, did not completely escape some of the negative side effects. Although all precautions were taken to support the teachers' work in an unstressful climate, some of the participants experienced moderate anxiety during the initial weeks of implementation.

C. Recommendations

Future implementations of this practicum will find the Handbook and the Activity File to be useful teaching

tools. The success of the program, however, also requires the active participation of a mathematically trained teacher. This master teacher will offer guidance, interpretation, and support on an ongoing basis. The teachers will need this help especially during the initial weeks in order to understand the children's mathematical behavior and the learning opportunities hidden in the daily curriculum.

Greater emphasis needs to be placed in the adult's acquisition of basic mathematical knowledge before the implementation takes place. Teachers failing to show an evidence of an elementary understanding of mathematics should not be included.

Teachers should be actively encouraged to share with the parents their own learning process. Many parents will benefit from this communication and acquire themselves a better understanding of the nature of children's mathematical development. Also, some of the parents will reveal themselves as valuable resources and contribute ideas, materials and, most importantly, valuable insights into their own child's cognitive growth.

D. Plans for Dissemination

The following ways to disseminate the materials and findings of this practicum are or will be explored:

- Presentations in local and regional early childhood conferences.
- Presentation of a workshop for directors organized by the local child care resource and referral agency.
- Sharing the materials with the teacher training program (kindergarten level) to be implemented at the Lawrence Hall of Science, University of California, Berkeley.
- Publication of the Teacher's Handbook.

References

Acredolo, C. Conservation-nonconservation. Alternative explanations. In Brainerd, C. J. (Ed.). Children's logical and mathematical cognition. Progress in cognitive development research. New York, Heidelberg, Berlin: Springer-Verlag, 1982.

Bagwell, B. Oakland. The story of a city. Novato, Calif.: Presidio, 1982.

Barbour Benham, N., Hosticka, A., Payne, J. D., & Yeotis, C. Making concepts in science visible and viable in the early childhood curriculum. School Science and Mathematics, 1982, 82, 45-56.

Baratta-Lorton, M. Mathematics their way. Palo Alto, Calif.: Addison-Wesley, 1976.

Baratta-Lorton, M. Workjobs II. Number activities for early childhood. Palo Alto, Calif.: Addison-Wesley, 1979.

Barron, L. Mathematics experiences for the early childhood years. Columbus, Ohio: Charles E. Merrill Publishing Company, 1979.

Beilin, H. The training and acquisition of logical operations. In Rosskopf, M. F., Steffe, L. P., & Taback, S. Piagetian cognitive-developmental research and mathematical

education. Reston, Va.: National Council of Teachers of Mathematics, 1971.

Bereiter, C., & Engelman, S. Teaching disadvantaged children in the preschool. Engelwood Cliffs, N.J.: Prentice Hall, 1966.

Brainerd, C. J. The origin of the number concept. New York: Praeger Publishers, 1979.

Brown, S. E. One, two, buckle my shoe. Math activities for young children. Mt. Rainer, Md.: Gryphon House, 1982.

Copeland, R. How children learn mathematics. Teaching implications of Piaget's research. New York: Macmillan, 1970.

Cruikshank, D. E., Fitzgerald, D. L., & Jensen, L. R. Young children learning mathematics. Boston: Allyn and Bacon, 1981.

Devaney, K., & Thorn, L. Curriculum development in elementary mathematics. Nine programs. San Francisco, Calif.: Far West Laboratory for Educational Research and Development, 1974.

Engelman, S., & Carnine, D. DISTAR Arithmetic I and II. Teacher's Guide. Chicago, Ill.: Science Research Associates, 1970.

Fennell, F. Early childhood and mathematics concerns regarding teacher preparation. School Science and

Mathematics, 1982, 82, 11-21.

Fuson, K. D. An explication of three theoretical constructs from Vygotsky. In Kieren, T. C. (Ed.). Recent research on number learning. Columbus, Ohio: ERIC/SMEE, 1980.

Gelman, R. What young children know about numbers. Educational Psychologist, 1980, 15, 54-68.

Gelman, R., & Gallistel, C. R. The child's understanding of number. Cambridge, Mass.: Harvard University Press, 1978.

Gibb, E. G., & Castaneda, A. M. Experiences for young children. In Payne, J. N. (Ed.). Mathematics learning in early childhood. Thirty-seventh yearbook of the National Council of Teachers of Mathematics. Reston, Va.: NCTM, 1975.

Ginsburg, H. Children's arithmetic. How they learn it and how you teach it. Austin, Texas: Pro-Ed., 1977.

Green, R. T., & Laxon, V. J. Entering the world of number. A step-by-step guide for parents. Over Wallop, Hampshire, England: Thames and Hudson, 1978.

Hohman, H., Banet, B., & Weikart, D. Young children in action. A manual for preschool educators. Ypsilanti, Mich.: The High/Scope Press, 1979.

Holt, M., & Dienes, Z. Let's play math. New York: Walker and Walker, 1973.

Howson, G., Keitel, C., & Kilpatrick, J. Curriculum development in mathematics. Cambridge, England: Cambridge University Press, 1981.

Kamii, C. Number in preschool and kindergarten. Educational implications of Piaget's theory. Washington, D.C.: National Association for the Education of Young Children, 1982.

Katz, L. Helping others learn to teach. Some principles and techniques for inservice educators. Urbana, Ill.: ERIC/EECE, 1979.

Kostelnick, M. Guidelines for effective "on-the-job" staff training. Child Care Information Exchange, Reprint No. 102, undated.

Maffei, A. C., & Buckley, P. Teaching preschool math. Foundations and activities. New York: Human Sciences Press, 1980.

Matthews, G., & Matthews, J. Early mathematical experiences. London: Addison-Wesley, 1982.

Nimnicht, G., McAffee, O., & Meier, J. The New Nursery School. New York: General Learning Corporation. Early Learning Division, 1969.

Osborn, A., & Nibbelink, W. R. Directions of curricular change. In Payne, J. N. (Ed.). Mathematics in early childhood. Thirty-seventh yearbook of the National

Council of Teachers of Mathematics. Reston, Va.: NCTM, 1975.

Payne, J. N. (Ed.). Mathematics in early childhood. Thirty-seventh yearbook of the National Council of Teachers of Mathematics. Reston, Va.: NCTM, 1975.

Piaget, J. Science of education and the psychology of the child. London: Penguin Books, 1977.

Piaget, J., & Szeminska, A. La genèse du nombre chez l'enfant. Neuchatel and Paris: Delachaux et Nestle, 1941.

Rosskopf, M., Steffe, L. P., & Taback, S. (Eds.). Piagetian cognitive development research and mathematical education. Reston, Va.: NCTM, 1971.

Siegel, L. S. The development of quantity concepts. Perceptual and linguistic factors. In Brainerd, C. J. Children's logical and mathematical cognition. Progress in cognitive development research. New York, Heidelberg, Berlin: Springer-Verlag, 1982.

Steffe, L. P. (Ed.). Research on mathematical thinking of young children. Six empirical studies. Reston, Va.: NCTM, 1975.

Steffe, L. P., & Smock, C. D. On a model for learning and teaching mathematics. In Steffe, L. P. (Ed.). Research on mathematical thinking of young children. Six empirical studies. Reston, Va.: NCTM, 1975.

Steffe, L. P. Quantitative comparisons as a readiness variable for arithmetical content involving rational counting. In Kieren, T. E. (Ed.). Recent research in number learning. Columbus, Ohio: ERIC/SMEE, 1980.

Sunal, C. S. Philosophical bases for science and mathematics in early childhood education. School Science and Mathematics, 1982, 82, 2-10.

Zappe, K. Ideas for inservice training. Child Care Information Exchange, November-December 1981, 33-37.

APPENDIX A

Parents' Questionnaire #1

PARENTS' QUESTIONNAIRE

Dear Parents:

As part of my graduate work in early childhood education at Nova University I am designing a staff development program to increase teacher competency in mathematics education for young children. The following questionnaire will help me to assess your feelings about the role of mathematics in the education of your child. Please take a few minutes to complete it. Your responses will contribute to a more vital math program at the Rainbow School.

Yours, Dora Halperin

Please Circle one:

1. My child will benefit from planned activities dealing with number concepts (counting, addition, subtraction).

Yes No Don't know

2. My child will benefit from planned activities dealing with sorting (classification) and ordering (seriation).

Yes No Don't know

3. Children should learn about shapes and solids during the preschool years.

Yes No Don't know

4. My child would learn a lot more if I'm informed about the math activities at school.

Yes No Don't know

PARENTS' QUESTIONNAIRE (Continued)

5. Would you like to receive suggestions for home activities to reinforce the acquisition of math concepts?

Yes No

6. Young children learn enough math incidentally (informally) at home and at school.

Yes No Don't know

7. What concepts do you nurture through conversation, games, toys, songs, etc., in your child? (Circle all that apply.)

cardinal counting	problem-solving
ordinal counting	numeral recognition
addition	numeral writing
subtraction	measuring
multiplication	telling time
division	fractions
classification	patterns
seriation	coin values
shapes	Other:
solids	

8. Math learning for my preschool child should be: (Rank in order of preference.)

_____ mostly free play and experimentation

_____ mostly guided discovery

_____ workbooks and paper and pencil tasks

PARENTS' QUESTIONNAIRE (Continued)

9. At what age should children start using the microcomputer to foster mathematical learning? (Circle one.)

Before age 2

Around the age of 2 or 3

Around the age of 4 or 5

In kindergarten

Later

10. Please evaluate your child's interest in mathematical learning.

11. Should mathematics be included in the preschool program? Please comment briefly.

THANK YOU FOR COMPLETING THIS QUESTIONNAIRE.

APPENDIX B

Teacher Questionnaire #1

TEACHER QUESTIONNAIRE

Dear Teachers:

As part of my graduate work at Nova University I am planning a staff development program designed to increase teacher confidence in the area of mathematics for the early years. In order to gather data which will help me to make this program a meaningful one, I prepared the following questionnaire. It will assess your opinions about the role of mathematics in the early childhood education curriculum. Please take a few minutes to complete the questionnaire.

Thank you, Dora Halperin

Please Circle one:

1. I plan structured activities dealing with number concepts:

never sometimes at least once a week

2. I plan structured activities dealing with spatial concepts (shapes, positional concepts):

never sometimes at least once a week

3. I plan structured activities dealing with classification/sorting:

never sometimes at least once a week

4. I plan structured activities dealing with seriation/ordering:

never sometimes at least once a week

TEACHER QUESTIONNAIRE (Continued)

5. LIST the mathematical concepts (number, shapes, sorting, ordering, problem-solving, addition, etc.) that you explore or teach informally (in circle time, during cooking, etc.) under the approximate frequency:

never sometimes once a week more often

6. Do you agree or disagree with the following statements?

- A Teacher's Guide would help me plan mathematical activities.

agree disagree

- An Early Childhood Math Activities File would help me plan structured mathematical activities.

agree disagree

- I need to find out more about what very young children (ages 2 to 5) can learn in math.

agree disagree

THANK YOU FOR COMPLETING THIS QUESTIONNAIRE.

APPENDIX C

Major Mathematical Concepts Relevant at the Early Childhood Level

1. Classification or Sorting
2. Comparing and Sequencing or Ordering
3. One-to-One Correspondence
4. Numbers: From Rote Counting to Meaningful Counting
5. Addition and Subtraction
6. Patterns
7. Fractions
8. Measurement
9. Problem-solving
10. Space and Shape: Topological Space and Euclidean Shapes

APPENDIX D

Written Test

EARLY CHILDHOOD MATHEMATICS

WRITTEN TEST

This test has been designed to evaluate the effectiveness of the Early Childhood Mathematics Staff Development Program. It will not be used to evaluate your job performance in any way. Your answers will be of great value in future revisions of this program.

Please use a separate sheet of paper for your answers.

1. You are asked to plan and implement a mathematics program for two- to five-year-olds in your child care center. Describe briefly how your program would be set up and the mathematical concepts you will explore with the children. (10 points)

2. Cuisenaire rods are one of the most interesting materials in the teaching of early childhood mathematics. List the mathematical concepts you can explore with Cuisenaire rods and give short examples of activities you would suggest to children. (10 points)

3. You decide that you need more materials to explore the sequencing (ordering) concept. Name two materials that you decided to buy and describe why you chose each of them. (10 points)

4. Parent involvement is very important in young children's learning. How could you encourage parents to provide mathematical experiences for their children? (10 points)

WRITTEN TEST (Continued)

5. Other than small-group "math time," describe good opportunities during the child's day at the center to encourage classification skills. (10 points)

6. Describe how you would conduct a small-group "math time" for four-year-olds on patterning. (10 points)

Circle the correct answer to the following items. Each correct answer will be worth 5 points.

7. Teachers of young children will introduce a mathematical concept:

A. verbally through definitions
B. by showing pictures
C. by allowing children to explore appropriate manipulative materials

8. A good mathematical program for young children will focus on:

A. small-group work
B. incidental learning opportunities
C. parent involvement
D. all of the above

9. Evaluation of children's progress is important because it lets the teacher know:

A. who is the smartest child
B. who is making the fastest progress
C. how each child is progressing

WRITTEN TEST (Continued)

10. In order to foster mathematical concept development in young children it is necessary:

A. to provide repeated opportunities to explore a concept

B. to insist on correct answers

C. to encourage memorization of definitions

11. Young children are very interested in the concept of time. Teachers should encourage this interest by:

A. teaching preschoolers to tell time

B. making children aware of the daily sequence of routine events

C. having children memorize the days of the week and the months of the year

12. Balloons are useful props to explore:

A. topological space

B. patterning

C. fractions

13. Good mathematical problems for young children:

A. are word problems

B. require only one simple step

C. involve the use of concrete materials

WRITTEN TEST (Continued)

14. Adults can help children acquire good counting skills by having children:

A. memorize the number sequence

B. attach the correct numeral to a set of objects

C. count and group objects

D. all of the above

APPENDIX E

Teacher Questionnaire #2

EARLY CHILDHOOD MATHEMATICS

TEACHER QUESTIONNAIRE #2

This questionnaire will help me evaluate the materials and format of the Early Childhood Mathematics Staff-Development Program. Please take a few minutes to complete it and feel free to add your comments and ideas that might improve the program. Thank you for your cooperation.

Check the answer that applies:

1. a. I liked the fact that the program was designed as a self-study course.

   b. I would have preferred regular meetings with the instructor to work on each concept.

2. The instructor was available for answers and clarification:

   Always Sometimes Never

3. The instructor provided (enough/not enough) guidance in addition to the Teacher's Handbook.

4. The resources (books, catalogs, math materials) provided by the instructor increased my understanding of early childhood mathematics.

   Very Much Somewhat Not at all

5. The Teacher's Handbook helped me understand the mathematical concepts that are developmentally appropriate for young children.

   TRUE FALSE

TEACHER QUESTIONNAIRE (Continued)

6. The work required of the teacher in order to complete the Teacher's Handbook was:

a. appropriate and interesting

b. appropriate but too much work

c. too difficult

d. too easy

7. How would you improve the Teacher's Handbook?

8. The teaching practice in small groups increased my confidence in exploring mathematical concepts with young children.

very much somewhat not at all

9. I found the Activity File helpful in planning small group "math time."

TRUE FALSE

10. I plan to add and expand the Teacher's Handbook with new information.

YES NO

I plan to add and expand the Activity File with new mathematical activities.

YES NO

TEACHER QUESTIONNAIRE (Continued)

Comments:

APPENDIX F

Parents' Questionnaire #2

EARLY CHILDHOOD MATHEMATICS

PARENT QUESTIONNAIRE #2

Dear Parents:

As a part of my graduate work at Nova University, I conducted a staff development program to increase teacher competency in the area of early childhood mathematics. This questionnaire will help me evaluate the effectiveness of this program and possibly improve it for future implementation. Please take a few minutes to complete it and feel free to add your personal comments. Thank you for your cooperation.

Please circle one:

1. I am aware that my child participates regularly in a planned mathematical program at Rainbow School.

TRUE FALSE

2. The participation of all the teachers in the center's mathematics program made me more aware of the content of "math time."

TRUE FALSE

3. The notes on early childhood mathematics posted on the bulletin board increased by understanding of how very young children learn mathematics.

TRUE FALSE

PARENT QUESTIONNAIRE (Continued)

4. The suggestions for mathematical activities were:

appropriate YES NO

interesting YES NO

fun YES NO

5. I actually followed some of the suggestions for activities and played several math games with my child(ren):

three or more times

once or twice

never

6. Teachers have talked to me about the activities my child has participated in during "math time."

more than once

once

never

7. I find the Progress Report Card helpful in understanding my child's progress in acquiring a mathematical understanding.

TRUE FALSE NO OPINION

8. I feel that mathematical learning will be enhanced if parents and teachers work together providing enjoyable mathematical experiences for young children.

TRUE FALSE NO OPINION

Please complete the following sentences:

A. I think the early childhood mathematics program at Rainbow School could be improved if teachers....

PARENT QUESTIONNAIRE (Continued)

B. I think the math program at Rainbow School could be improved if parents....

Comments:

APPENDIX G

Teacher's Handbook

Young Children's Mathematics

A Handbook for Teachers In

Child Care Centers and Preschools

YOUNG CHILDREN'S MATHEMATICS

A Handbook for Teachers

in

Child Care Centers and Preschools

by

Dora Halperin

Oakland, California

1984

INTRODUCTION

The purpose of this Handbook is to explore the meaning and the developmental significance of the following mathematical concepts:

1. Classification or Sorting
2. Comparing and Sequencing or Ordering
3. One-to-One Correspondence
4. Numbers: From Rote Counting to Meaningful Counting
5. Addition and Subtraction
6. Patterns
7. Fractions
8. Measurement
9. Problem-solving
10. Space and Shape: Topological Space, Euclidean Shapes

Each mathematical concept will be defined and its role in the early childhood cognitive development will be briefly explained. You will complete this section with your own observations of children's behavior relevant to the concept under discussion.

The following section (The Teacher's Role) will help you make important decisions about the teaching of mathematics to very young children. You will be asked to conduct a sort of treasure hunt through your child care center or preschool (and through your imagination and creativity) in order to become familiar with the materials and equipment that will be helpful in exploring a given topic.

You will identify the mathematical learning opportunities that arise spontaneously during daily routines, inside and outside free play, circle time and story time. You will be encouraged to support and expand this incidental learning through stimulating questions and suggestions.

The Activity File that accompanies this Handbook and other available resources will help you plan activities for a small group of children in order to focus on a specific mathematical concept or skill. Soon your experience in working on mathematical ideas with young children will enable you to design your own materials and activities. You are encouraged to expand the Activity File with new ideas and games that you created or gleaned from new resources.

Furthermore, each chapter will ask you to describe one activity that parents can do with their children at home. A close cooperation between school and home will help children understand and expand the mathematical ideas and skills that you are teaching.

An Extending Yourself section will present you with a challenge to go beyond the basics. You may want to work on this section now or you may wish to complete it in the future after you have worked with young children and their mathematics for some time.

After you have worked on all the sections, you will have an invaluable resource and a practical guide. The Handbook will contain both a summary of the knowledge you have acquired and an important record of your observations, ideas, and activities that you have implemented. You may want to continue adding new ideas, activities, and resources and review periodically in order to

create a rich and rewarding mathematics program for the young children in your care.

A few words about ....

Young Children's Mathematical Experiences

- Children are active, willing learners and learning is a joint and joyful adventure between teacher and child.
- Manipulative activities with concrete materials and appropriate questions by the teacher provide a firm basis for mathematical understanding in the early years.
- Mathematics is only partly about numbers and calculation. Math is also about such unlikely things as family relationships, puzzles, drawing shapes, paper cutting, completing patterns, and solving problems.
- Our activities will not teach a child mathematics. Classroom experiences will encourage an open-minded attitude in young children and develop their potential for clear thinking. In this way, children will gradually construct their own mathematical knowledge.
- Mathematics is the study of how things link up, how things relate.
- Do not worry about mistakes, the children's or yours! Make deliberate mistakes once in a while. Admit your own mistakes cheerfully.
- Do not scold errors. Do not correct. Ask the child how she arrived at that result. The learning process is more important than the correct answer. Always ask, even if the answer is

correct. Errors are useful evidence of the child's thinking and learning processes.

- Keep the lessons short. Always stop before your group gets bored. If they want more, suggest a different activity or explain that you will repeat the activity at some other time.
- Let children use materials in their own way. After they are familiar with the materials, model or explain the rules you had in mind.
- Grab the children's interest. Listen to your group. Like a good actor, you have to be ready to play to your audience on the spur of the moment.

A few words about ....

Selecting and Evaluating Instructional Materials

The teaching method emphasized in this workbook requires the use of concrete materials to help young children conceptualize mathematical ideas. Because of the abundance of teaching aids available, it is important to exercise good judgment in selecting materials for your preschool or day care center. These are some of the criteria to consider in the selection of manipulative materials.

- The material should be interesting to the child. Children should be allowed to explore any manipulative aid for a considerable time, sometimes even for several sessions, before using it in a structured activity.
- The aid should serve to teach several mathematical concepts. This encourages children not to tie any one concept to a particular

material and hence promotes mathematical abstractions.

- The aid should serve as a learning device for children at various levels of concept development.
- The material should withstand normal use by the children.
- The material should not require excessive space for use or storage.
- The commercial product should offer utility and attractiveness that a similar teacher-made product would not offer.
- The level of difficulty of content and format should be appropriate for the intended age level.
- The cost of the material should not outweigh its cirricular function.

1. CLASSIFICATION OR SORTING

Classification serves as a basis for the development of both logical and mathematical concepts. Very young children classify when they apply identity labels such as cookie or ball to a ball or a cookie they have never seen before. Learning about classification is an ongoing process that ranges from sorting games in its earliest form to the hierarchical classification of older children and adults.

Classification is the process of sorting or grouping objects into classes or categories according to some systematic principle. An object belongs to a class or category if it has some property in common with the other objects in the class. Classification is a means by which children and adults can cope with the multitude of objects in our experience by grouping them in order to be able to see simple relationships.

Children's early experiences with classification involve grouping by one obvious property: "all the blue balls," "all the red triangles." Children will find the simple identity (cars) criterion the easiest. They will progress to larger identities (toys), to properties (blue objects), to use or function (things that cut), to a combination of attributes (things that are blue and roll).

* Observe a preschool child during a spontaneous sorting activity. Describe the way she/he classified the objects played with.

The Teacher's Role

Classification activities will provide a variety of experiences using small collections with few attributes or large collections with several attributes. The task may be prescribed by the teacher or carried out independently by the child. The classification criterion may be determined either by the child or established by the teacher.

Materials

Many materials designed specifically for sorting activities are commercially available. The apparatus most widely used is a set called Logic Blocks or Attribute Blocks. It consists of sixty wooden or plastic blocks that vary in color, shape, thickness, or similar attributes which are easily observable by children.

* Secure a set of Attribute Blocks and familiarize yourself with the different sorting possibilities. Now list two simple sorting activities for young children using the Attribute Blocks.

  1.

  2.

* Find two other commercial materials at your center that may be used to foster classification skills:

  1.

  2.

* Check a school supply catalog and find one sorting toy or game you would buy. Briefly state why you consider it a valuable teaching material:

Not all valuable sorting materials are commercial. Children often enjoy classifying such objects as shells, bottle caps, or buttons. A box of "junk" will provide endless opportunities for classification games.

* What environmental materials could you provide to foster classification skills?

1.

2.

Planned Small-Group Activities

When planning small-group work to explore classification concepts, the teacher will begin with activities that involve sorting by only one property. The materials used in these early experiences will vary by only one attribute; for example, a collection of blocks that are alike except for color. As children become more proficient and are able to do more difficult classification activities, the complexity of the task should be increased. This may be done by increasing the number of objects to be classified; increasing the number of categories into which the objects may be sorted; increasing the level of abstraction of the categories, farm versus zoo rather than blue versus red.

An additional level of difficulty will be present in the

problem of overlapping classes. For example, if children are sorting "things that have wheels" and "things that are red," then a red car will fit into both categories. The use of overlapping loops of yarn will help children visualize this problem in a clear fashion.

* Describe one small-group activity in classification for each of the three age levels (approximate):

  Activity for two-year-olds:

  Activity for three-year-olds:

  Activity for four- and five-year-olds:

Incidental Learning

Many every day activities at school and at home involve sorting. For example, children classify during clean-up time while putting away the blocks. At home, children will sort if their parents involve them in preparing the laundry for the washer or in putting away the groceries after a trip to the supermarket.

* Name two sorting activities that occur spontaneously during the preschool day:

  1.

  2.

Activities for Parents

* Name one sorting activity that parents can do with their children at home:

Extending Yourself

* Design a set of attribute materials different from the commercial ones you have seen at your center or in catalogs.

Books for Children

Gillespie, D. Craig. Weeple People: A Sciencing Unit. New York: McGraw Hill Book Company, 1972.

Martin, Bill. This Is My Family. Little Owl Series. New York: Holt, Rinehart and Winston, Inc., 1971.

Songs

Software

Gertrude's Secrets (The Learning Company)

Moptown Parade (The Learning Company)

A few words about ....

Using Logical Words

Mathematics should arise from the children's activities and alongside the development of their vocabulary. Logical terms of not, and, all, some, and none should be incorporated into activities on classification. As children work with attribute blocks, for example, stress logical terminology: some of the yellow blocks are large and some are small; some of the square blocks are red but none of the square blocks are triangles; all of the blocks are made of plastic. Ask questions dealing with two or three attributes: "Find the blocks that are blue and circular (round)." "Which block is blue, square, and large?" "Find the blocks that are small or square." Many young children will find it difficult to grasp the concept of "or" but it should be used often in formal and informal situations.

Be alert to opportunities to reinforce the use of logical words. "Did all the children bring lunch?" "Some children will go on a field trip today." "Stand up if you are four years old and a boy." "Stand up if you are a girl or if you are wearing red." "None of us comes to school on Sundays."

Sets

When objects are sorted they are put into sets. A set is a collection of objects (called elements or members of a set). Children will learn about sets by working with many concrete examples. In beginning experiences children usually represent sets by placing yarn loops around the objects.

As a teacher you will provide plenty of experience in

classification and you will use the word set (and even subset) quite often. You will also use the word informally with children (a set of cups, a set of cards, a set of pictures, a set of clothes) but do not try to teach young children the new math. Many basic aspects of set theory such as the intersection of two sets may be difficult for preschoolers. The main aim of these early mathematical experiences is to give children frequent opportunities to explore and discover without insisting on performance or mastery. Through the manipulation of sets in early addition and subtraction problems such as, "If I have two blue cars and three green cars, how many cars do I have altogether?" young children will be building their understanding of sets while they are learning about numbers.

2. COMPARING AND SEQUENCING

a. Comparisons

Comparisons involve an awareness of similarities and differences that may be visual or of texture, weight, temperature, or taste. The range of comparisons is very great: shorter than, heavier than, smoother than, and so on. Comparison is a necessary concept for the understanding of number. Eventually children will understand, for example, that five is greater than four by comparing a set of five objects with a set of four objects.

Comparison is also preliminary to ordering. As soon as there are more than two objects to be compared, they will be ordered according to a particular relationship.

Young children begin by describing objects in absolute terms: "This is the big one and this is the little one." It is only later that they use the comparative statement: "This one is bigger than that one." With help from adults, children will learn the appropriate words and the "big tree" will become the "tall tree." Soon the child will start talking about "a tree that is taller than the one in the garden," and a "big kid" will be referred to as "an older kid" or a "taller kid."

Children will enjoy comparisons such as "Paul is taller than John," but they will need help with the reverse, "John is shorter than Paul." Soon they will discover the complexities of such facts as being the oldest but not the tallest, or being older than Jenny but younger than Timmy.

Young children are generally unable to concentrate on more than one characteristic at a time. This makes double comparisons

difficult for the preschool child. It is the role of the adult to bring to the attention of the child more than one detail of an object when the occasion arises. "This box is shorter and wider than that one." "My doll is smaller but heavier than Lucy's."

* Observe children's play and note the instances in which children formulate comparisons. Write down several examples stating the age of each child.

The Teacher's Role

The adult has to take every opportunity to expand the comparison idea. When a child claims she built the biggest sandcastle, the teacher may want to explore the reverse expression or compare the sandcastle according to other dimensions or characteristics. A careful use of words will refine children's understanding of the various words used to describe length, height, depth, width, and so on. Comparisons of weight, for example, may be refined by examining the objects, then by holding them, and finally by using a scale or balance.

* Describe one instance in which you expanded and refined a child's spontaneous comparison.

b. Ordering and Sequencing

Ordering builds on comparing. Comparing is forming a relationship between two objects while ordering is a relationship between an object and a set of objects. Each object occupies a unique place in a sequence determined by the relationship. In ordering, the arrangement must have an origin and a direction and must reflect a rule. For example, objects can be ordered from shortest to longest and sets can be ordered from those with the most elements to those with the fewest elements, or in the opposite direction.

Children can order objects according to many criteria: length, height, weight, area, intensity of color, volume, degree of hardness, and so on. Children also can order events in time. This can be done verbally or pictorially using appropriate materials. Children's first attempts at ordering objects often result in correct responses for the first and the last objects in the sequence but incorrect responses for the objects in between.

* Observe children's play and record two instances of spontaneous ordering.

1.

2.

The Teacher's Role

Ordering activities are of four basic types:

Copy - Children will be given a sequence and asked to copy in

the same order, or, later on, in a reverse order.

Extend - Children will be given an ordered set of objects and asked to extend the sequence.

Fill gaps in the sequence - Children will be given a sequence that has gaps in it and asked to fill the gaps.

Invent an order for a set of objects - Children will be given a set of materials having ordinal properties and asked to decide on the property or criterion according to which the set will be ordered.

It will be the teacher's responsibility to assemble the appropriate materials such as stacking and nesting blocks and to design ordering activities of increasing difficulty.

Materials

Many commercial materials have been designed specifically to embody the ordinal principle. The Montessori knobbed cylinders and the Montessori knobless cylinders are among the best known ordering materials. If your center owns these materials, take a few minutes to familiarize yourself with their characteristics.

* List two other ordering toys found in your child care setting.

  1.

  2.

* Examine several school supply catalogs and decide on one sequencing toy you would recommend that your center should acquire. Describe the toy and state the reason(s) you like it.

Not all valuable ordering materials are commercially designed. For example, children enjoy sequencing sandpaper samples according to the degree of roughness or paint chips according to the intensity of color.

* Describe two sets of ordering materials which you could make or fine in the environment.

1.

2.

Planned Small-Group Activities

* Now that you are familiar with the materials, describe two ordering activities appropriate for small-group work.

1.

2.

Incidental Learning

Not all ordering activities will take place during planned small-group work. The preschool day offers many opportunities to foster sequencing skills. A child playing with the dollhouse may decide to order the doll family according to size. Another child may sequence the pots in the housekeeping area. Cooking time and the block area also offer many opportunities for ordering.

* Describe two incidental learning opportunities in which ordering can be explored with children.

1.

2.

Activities for Parents

Sequencing can be further reinforced if parents are aware of the opportunities to play sequencing games at home with their children.

* Describe one sequencing activity that parents would enjoy doing at home with their young child.

Extending Yourself

* Design a game for young children based on seriation.

Books for Children

Goldilocks and the Three Bears (many editions).

The Three Billy-Goats Gruff (many editions).

Ipcar, D. The Biggest Fish in the Sea. New York: Viking Press, 1972.

Songs

Software

3. ONE-TO-ONE CORRESPONDENCE

The idea of one-to-one correspondence is one of the most basic concepts of mathematics and is a prerequisite to a meaningful development of counting. The skill of one-to-one correspondence is important in determining if sets are equivalent, which in turn is the foundation of the concept of cardinal number.

One-to-one correspondence is a basic mathematical relation and is not dependent on number. Determining that there are as many chairs in a room as there are children, for example, requires only that each child sit in a chair, that all the children have a chair to sit in, and that there are no unused chairs; that is, making a one-to-one correspondence between children and chairs. Neither the children nor the chairs need to be counted.

If the objects in two sets match one to one, there is more than one way to demonstrate it. It is necessary that children come to realize that if two sets can be put in a one-to-one correspondence, then the sets will always be equivalent regardless of the way the objects are matched. The failure to recognize this invariance shows that the child has not yet acquired an adequate number concept.

Children will be able to work with small sets (up to five elements) before they are ready to match larger sets in a one-to-one relationship. They will be able to match objects in natural situations where there is some need for the matching, before they become skillful at more abstract matching. Also, they will be more successful at matching objects at first if they are provided with the exact number of objects for both sets. For example, if the

teacher wants a child to match six cups with straws, the child will be more successful if the teacher provides him with six straws. After children have had some practice with these activities, the teacher may ask the child to get <u>just enough</u> straws for the cups on the table. This is more difficult for the child because she has to decide on a strategy to accomplish the task.

* Observe children at play and in daily routine situations. Record two spontaneous incidents of one-to-one matching.

1.

2.

<u>The Teacher's Role</u>

Once adults understand the fundamental importance of one-to-one matching in the acquisition of the number concept, they will be aware of the opportunities in the daily routine to put objects (or children) into a one-to-one relationship. It is important for the teacher to know that there is a great difference between putting a spoon in each bowl and thinking about the total number of bowls in relation to the number of spoons. The former is a relationship between single objects while the latter is the relationship between groups of objects.

<u>Materials</u>

Commercial materials specifically designed for one-to-one matching are not commonly found in catalogs or school supply

stores. However, there are many versatile mathematical materials that may be used in teaching this concept. Blue cubes can be matched to red cubes or a set of green bear counters can be matched to a set of yellow bear counters. The richest opportunities to foster the one-to-one correspondence idea will be found in activities using environmental materials (jars and lids, red beans and pinto beans, paper cups and popsicle sticks) or toys generally found in the home or the center (cars and toy people, square blocks and triangular blocks, paint cups and brushes).

* What commercial materials found at your center could be used to teach one-to-one correspondence? List as many as you can.

* What materials would you recommend that your center buy in order to provide children with practice in one-to-one matching?

The importance of one-to-one matching has not been fully understood by commercial designers of teaching materials. Teachers need to collect materials and prepare their own activities with objects found at home, school, or the yard.

* Describe <u>two</u> sets of materials which you could assemble, find, or make to encourage one-to-one matching.

1.

2.

Planned Small-Group Activities

In beginning activities on one-to-one correspondence, children should physically match complementary sets such as cups and saucers, flowers with vases, horses with riders, or seals with balls. After children are able to perform the easier task of matching complementary sets, they will need experience in demonstrating one-to-one correspondence between noncomplementary sets such as matching balls with balls or squares with circles.

An extension of the mentioned activities will familiarize children with the terms "more than," "fewer than," and "as many as." Children should have ample opportunity to match nonequivalent sets. The teacher will help children discover that one set sometimes is left with one or more elements unmatched.

* Plan two small-group activities in one-to-one matching for each of the three age levels you are withing with.

Activity for two-year olds:

1.

2.

Activity for three-year olds:

1.

2.

Activity for four-year olds:

1.

2.

Incidental Learning

One-to-one matching is learned best from natural situations where children can see a need and function to the matching. Giving a cup to each child at snack time or figuring out how many party favors are needed so each invited child gets one are ideal situations that help children to understand this fundamental concept.

* Describe two everyday situations in which children may practice one-to-one matching.

1.

2.

Activities for Parents

Since the home offers so many opportunities for the learning of this concept, it is important to enlist the parents' cooperation in reinforcing the one-to-one correspondence.

* Suggest one matching activity that parents could conduct at home.

Extending Yourself

* Develop a story and picture book illustrating one-to-one correspondence.

Books for Children

Goldilocks and the Three Bears (many editions).

Songs

Software

4. NUMBER: FROM ROTE COUNTING TO RATIONAL COUNTING

Counting and the development of the number concept is the central topic of the early childhood mathematical curriculum. Properly structured meaningful counting activities for young children will lead to improved performance in both number skills and logical operations.

Number is an abstract idea and many experiences are needed before "five" or "seven" are fully and functionally understood by the child. The idea of "five" cannot be perceived the way "red" or "square" can be experienced. Children construct the idea of "five" through the repeated experience of sets of five: five fingers, five toes, five toy trucks, five teddy bears, and so on until the fiveness is abstracted from the concrete experience with objects.

Several basic ideas are part of the concept of number. Children acquire the idea of set through sorting; they acquire the skill of one-to-one matching and finally come to understand the meaning of the number sequence through comparison and ordering. Number concepts are acquired through the maturation and practice of all the concepts mentioned above as well as through the direct experience of counting. The well-balanced early childhood mathematics curriculum will provide activities dealing with all aspects of numbers throughout the year.

Learning to Count

Children struggle with counting for years. They learn the number words, they use them in games, and sing them in songs. This is rote counting. Children memorize the number names and gradually learn to repeat them in their proper sequence. At this point the

number sequence has no more significance for the child than the sequence of letters that form the alphabet.

Learning the beginning of the sequence, the first twelve or so numbers, has to be done in a rote fashion since it is completely arbitrary. After some time children discover that the numbers after thirteen contain an underlying pattern. Using it, they develop a few simple rules by which to generate numbers up to one hundred and beyond.

Counting Things

This is a new and different skill from rote counting. Initially, the way children count objects is highly inconsistent. They may count an object twice, skip it altogether, or go on rote counting after all the objects are gone. Typically children can say the number words quite well up to a reasonable limit but cannot count a set of things whose number is well below that limit.

* Observe - Play with a three-year-old and have him/her count for you. Note how far she/he counts correctly (in rote fashion). Then, set out that number of cubes or buttons and ask the child to count the objects. Describe what happens. Repeat the experience with one of the older four-year-olds. Describe.

Why is counting so hard?

To count properly children have to be able to do the following:

- To say the number words in their proper order.
- To count each number of the relevant set once and only once. Children must not count one object two times or forget to count an object.
- To make a one-to-one correspondence between each number word and each thing. The word one has to go with this object and two with that object. Each object must be assigned one and only one number word.

Young children use a haphazard procedure in counting. They lack a systematic plan for making sure that each object is considered once and only once. This puts a great strain on their memories: to be correct they have to remember the characteristics of each individual object touched. Also they find it hard to make the one-to-one correspondence between the numbers they say and the things they touch.

In spite of these difficulties, children start counting things very early and enjoy counting their fingers, their toys, their cookies. Although at first their counting is inconsistent, they are not disturbed at all by such inconsistencies. In time, children develop strategies to count more accurately. They spontaneously develop grouping strategies which allow them to determine number in increasingly efficient ways: they arrange objects in rows, they separate the items already counted. They

also learn to perceive small numerosities directly and no longer need to count them. This is called subitizing.

Subitizing or Instant Recognition of Number

Through repeated experiences counting objects, children develop the ability to subitize or to recognize instantly small quantities without the need to count the objects. Preschoolers usually subitize quantities up to and including five.

It is very important that children learn to label small sets without counting them. Don't encourage counting when dealing with small sets. The ability to subitize helps in building children's real understanding of these small number words and aids in the grouping of elements.

The Teacher's Role

Teachers of young children need to give special support to children's counting. There are two important reasons for this. One is that counting in one form or another is likely to be the preschool child's main mathematical interest. The second reason is that counting is very basic to all of arithmetic, since many problems in arithmetic can be solved by counting.

There are many specific ways in which adults can help. When very young children are trying to learn the number names, the teacher can sing or say the nursery rhymes for memorizing the first ten or so numbers.

Teachers can also help by encouraging children to count objects. They need repetitive practice in this. They need different things to count. Also, the adult can help them to learn good strategies

to count things once and only once by teaching them to push things aside after they have been counted. After they have learned to count one by one, the teacher can show them how to group and count by twos and maybe even by fives.

Materials

The list of interesting materials for counting practice is probably endless. There are commercially available counters, cubes, cups, teddy bears, and so on. In this area, however, naturalistic materials such as bottle caps, raisins, cookies, or pebbles seem to be more interesting to the young child.

* List the commercially made counting materials found in your center.

* Describe one commercial counting game (or material) that you would recommend your center buy.

* List five counting materials that you could collect or find.

1.

2.

3.

4.

5.

Planned Small-Group Activities

The teacher will develop activities for small groups that provide opportunities for counting. These activities will involve not only the use of a variety of manipulative materials, but also the whole body in clapping, jumping, climbing steps, and so on. The teacher will also provide opportunities to count symbolic materials such as pictures of appl-es, puppies, balloons, and so on.

* Describe three games that involve counting and are appropriate for small-group work.

1.

2.

3.

Incidental Learning

Counting occurs spontaneously all through the child's day. A child will count blocks in the tower she is building or the animals she lined up for the parade. Children will count other children when they get ready to go on a walk or a field trip. Even story time is often a good time for counting.

* Observe - Watch children at free play during two hours and record all the opportunities in which a child counted spontaneously (with no adult encouragement).

* How can counting be encouraged in the following areas of your center:

In the housekeeping area:

In the manipulative area:

In the yard:

Activities for Parents

Parents, like teachers, can help children practice their counting skills. Parents need to be reminded often of their role in their child's mathematical learning and of the importance of counting in young children's arithmetic.

* Describe two activities that you would encourage parents to do with their child to provide counting practice.

1.

2.

Extending Yourself

* Observe a four-year-old child who has trouble counting objects. Develop a five-step plan to improve his counting skills.

1.

2.

3.

4.

5.

A few words about ....

Cardinal and Ordinal Number

When we adults count a collection of objects, the last number word we say turns into a number concept that applies to the whole collection. If we count six objects, six is a property of all objects counted and not just of the last thing to which we happen to point. Six is the cardinal property of the collection. Adults recognize that the order in which they count does not matter and they know that arrangement and appearance of a collection is irrelevant to its number. In short, cardinal number answers to the question "How Many?"

Numbers for young children function as names long before they become concepts. Children may be able to count objects accurately,

but if asked "How many do you have?" they are unable to give the cardinal number of the set. A clear example of the number as name is seen when children are counted for a field trip or any other reason. Very often a child will be puzzled when the number assigned to him in the counting sequence does not coincide with his age. Adults also use numbers as names on license plates or as a designation for bus lines, for example.

With rote counting and later with tally counting the child deals with ordinal numbers and the serial property of numbers. While rote and tally counting the child is essentially naming the position of each object in the series. Ordinal counting leads to the cardinal concept. In other words, ordination comes before cardination in the cognitive development of children. The accurate use of number words in a proper sequence does not guarantee the understanding of the cardinal number concept. This will occur when the child fully comprehends not only that the last number said in the counting of a set of objects answers the question "How many?" but also that this six-ness, for example, of a set of six apples, is a label that refers not just to that particular set, but to an attribute of amount shared by all sets that carry this label.

It is important that teachers understand and keep in mind the distinction of ordinal and cardinal number. An accurate use of words will help children develop an understanding for the different function of ordinal as well as cardinal numbers. When teaching cardinal number, encourage counting and labelling of the set (1, 2, 3, 4. There are four teddy bears in this basket). If you are

working with ordinal numbers, the child will count: first, second, third, fourth. "The fourth teddy bear is the red one," or, "The first teddy bear is small but the third one is bigger."

In summary:

- Cardinal number answers the question: "How many?"
- Ordinal number shows the position in a sequence.

Concept of Zero

Zero presents unique problems to the child. Children can state that they do not have any cookies, but it is difficult for them to say that they have zero cookies. Having zero seems to be a more difficult idea than not having any.

Teachers will be able to help children learn the meaning of zero through counting-backward songs, games in which the object is to get rid of the playing pieces such as dominoes, and through the frequent labelling of empty sets ("There are zero real elephants in our classroom," or, "The bananas are all gone. We have zero bananas left," and so on).

Numerals

Numerals are the symbols used to represent numbers. Children learn numerals the same way and at the same time they learn the letters in the alphabet. They will need considerable help and practice in attaching the symbol to the number; they need to be told that the numeral for one is 1, the numeral for two is 2, and so forth. They will need to work on the flannel-board, have tactile experiences with wooden, plastic, and sand numerals. They will need

to trace numerals, copy them, trace them in salt or cornmeal, in the air, or in their hands. Eventually, towards the end of the preschool years some children will be able to write them independently.

A word of caution: Young children will be able to recognize and write numerals and this is a valuable early skill. However, young children will not be able to use written numerals for their practical arithmetic. Presenting a written addition problem (2 + 2 =) is not developmentally appropriate during the preschool years, although children are able to solve the same problem presented with manipulative materials. In brief, there is a discontinuity between children's practical arithmetic and their ability to do written arithmetic.

Books for Children

A few words of caution about number books for young children.

To be effective in providing counting practice and aid in the development of the number concept, picture books must:

- Have clear and distinct illustrations of items that can be easily counted. Overlapping drawings or scenes which are too busy will distract the child from the basic idea of counting the elements of a given set.
- Be aware of the cardinal/ordinal distinction and perferably deal with one of the concepts only. Some very famous and otherwise charming number books obscure this distinction and interfere with the process of number concept acquisition (for example, Maurice Sendak's One is Johnny).

Number picture books, like alphabet books, are a favorite with authors and illustrators. A list of number books would be endless. At the same time, picture books provide valuable opportunities for warm teacher-child interaction and learning. Teachers need to familiarize themselves with good counting books and use them frequently in their center.

* Visit a library and select ten (10) counting books. Examine the books and rank them (first being your favorite, etc.). Very briefly describe each book and point out its good or not so good points. Use the remainder of this page and the following blank page for this purpose.

(Library book evaluation)

Songs

Songs can be a very useful device for the memorization of the number sequence. Some, like Five Funny Freckled Frogs or Five Little Monkeys, deal with backwards counting and can be used to teach the concept of zero.

* Keep a list of number songs you know. It will probably start with:

1. One, Two, Buckle My shoe
2.
3.
4.
6.

Software

Sticky Bear Numbers (Xerox)

Alphabeasts - the section that deals with numbers (The Reader's Digest)

Children's Carousel (Dynacomp)

5. ADDITION AND SUBTRACTION

Young children can count, they have an intuitive idea of number and they refine this idea through their interaction with the environment in free play and the tutoring of older peers and adults. At four or five years of age they begin to combine their counting skills with their mathematical ideas. The result is practical arithmetic or the child's way of dealing informally with real world mathematical problems.

Practical arithmetic problems that involve addition and subtraction may seem trivial to the adult. The young child, however, does not yet know the addition facts and therefore cannot simply remember, as the adult does, the sum of two and three. Children have to interpret the problem, decide if they have to put things together or take some away. If the children are presented with three red blocks and two blue blocks and are asked how many there are altogether, some four-year-olds will realize that the answer can be obtained by combining the sets. Most three-year-olds do not interpret this problem correctly.

After they decide that they need to put things together, young children have to implement their strategy; they need to move the blocks together and count them or simply count but they need the physical or symbolic (picture) presence of the objects. Furthermore, some children are very precocious in the addition of imaginary objects ("How many are three cows and one cow?"), but all children benefit from this exercise once they become experts in the addition with objects they can manipulate.

The above-mentioned steps of interpretation and implementation also apply to problems involving subtraction ("You have three blocks and decide to give two blocks to Johnny. How many blocks did you keep?"). Children will need the same manipulative materials they use for addition and lots of opportunities to explore and resolve subtraction problems. Children need to experience both addition and subtraction with small numbers at first: the total for addition should be five or less until children are consistently successful in solving the given problems.

In working with numbers by adding and subtracting, children will begin to understand the nature of transformations that change quantity and differentiate these from apparent transformations where only the arrangement but not the quantity is changed.

* Observe - Select a three-year-old and present her with addition and subtraction problems using counters or small blocks. Play for approximately ten minutes and describe what happened.

* Repeat the above procedure with an older four-year old. Describe the differences.

The Teacher's Role

Early addition and subtraction problems are based on the manipulation of sets and should be based on concrete experiences. Have available all types of simply counters, dried beans, buttons, and so on. On other occasions present children with a number of dissimilar objects (a block, a car, a pencil) so that children will not develop the idea that only elements that have some characteristics in common other than belonging to a set can be added or subtracted.

The teacher will ask many questions to stimulate children's thinking. The following is a typical series of questions:

"How many are there?"

"If I take one away, what will happen?"

"If I give you two, how many will there be?"

The teacher might want to move the items around, without adding or taking any away, and ask:

"How many are there? Are there still three?"

"Are there still the same number as we had before or are there more/less(fewer)?"

Repeat the process with up to five items, adding and subtracting one until the child has grasped the idea and is also able to tell whether they are the same, more, or less. Always reinforce what the child says: "Yes, there are three," or, "Yes, there are more." If the child is wrong, say "No, let's try again." If the child is consistently wrong stop, do something else, and try again a few weeks later. Frequently ask, "How can you tell?" whether the answer is right or wrong. This will help children reflect on their thinking.

Addition and subtraction (and counting) should permeate the early childhood mathematics curriculum and be practiced in games, free play, and daily routines.

Materials

Counting materials, both commercial and environmental, will be used for adding and subtracting.

Planned Small-Group Activities

* Describe three activities or games designed for small-group work that will encourage children to add and subtract:

1.

2.

3.

Incidental Learning

* How could you encourage children to add or subtract during circle time?

* How could you encourage children to add or subtract in the block area?

Activities for Parents

* You want parents to help you reinforce addition and/or subtraction skills. Suggest (and describe) one activity parents could do with their child while preparing dinner.

Extending Yourself

* Do two-year-olds add? Play with several two-year-olds and report your findings.

Books for Children

Bruslein, A. One, Two, Three, Going to Sea. Menlo Park, CA: Addison-Wesley Publishing Company, Inc., 1964.

Morse, S. F. Sea Sums. Boston: Little, Brown & Company, 1970.

Scarry, R. Richard Scarry's Best Counting Book Ever. New York: Random House, 1975.

Stemer, C. Ten in a Family. New York: Alfred A. Knopf, Inc., 1960.

Songs

Software

Sticky Bear Numbers (Xerox)

A few words about ....

Conservation

Conservation, cognitively speaking, is the ability to understand that certain properties such as quantity, length, area, volume, and so on, remain constant even when the appearance changes, if nothing is added and nothing is taken away. Young children's notion of sameness relies on appearances, not reality. If a row of six candies spaced apart looks longer than a row of six closely spaced candies, the young child will probably believe that the first row has more candies than the second row. Gradually, children develop more effective ways to assess sameness than just believing their eyes. By the age of five to seven, children conserve number. In other words, they know that five pennies are the same, are always five, no matter how they are arranged, if no coin is added or taken away.

This concept does not appear all at once; it develops slowly and may appear earlier or later, depending on the child and the property involved. Young children are able to conserve small quantities before they extend this understanding to number in general. They will be able to conserve number before they can conserve volume or area. No child ever learns to conserve under all possible circumstances. Certain problems puzzle even the average adult, such as judging volume in different shaped containers. It is often necessary to check weight or volume on package labels while shopping in the supermarket in order to know which one contains more.

Until a child has the conservation concept, she is not capable of any truly quantitative reasoning, nor of performing any mathematical

operations with real understanding. Laying the groundwork for conservation is the goal of many of the mathematical activities for children between the ages of two and five, so that when they start school they will be able to work with numbers with a greater degree of understanding.

6. PATTERNS

A pattern is the repetition of distinctive elements. Pattern recognition is the act of becoming conscious of regularities. A fundamental cognitive skill, pattern perception lays the groundwork for developing the ability to form abstractions and generalizations.

Young children develop first the ability to copy a pattern. Although it appears to be a simple skill, copying patterns prepares children to analyze data in much the same way a scientist does. The relationships discovered by children during these first activities will prepare them for more sophisticated pattern activities such as filling in parts of patterns (interpolation), extending patterns (extrapolation), and inventing patterns (hypothesizing).

* Observation - Observe children during free play. Describe two instances where children created patterns spontaneously. Describe where it happened, materials used (if any), age of the child(ren).

1.

2.

The Teacher's Role

Patterning activities should happen frequently since children work at a high intellectual level when they string a bead necklace

identical to a given one or make a pattern with colored blocks. Incorporating patterning into the curriculum is easy and inexpensive. It provides numerous opportunities for individual success and for the exchange of methematical ideas.

Patterns can be presented in a variety of modalities: motor, auditory, or visual. Such a diversity of patterning activities will enrich the child's experience and set the stage for later understanding of more abstract patterns such as the systematic occurrences on an addition chart. Learning to recognize predictable occurrences is an ability essential not only to mathematics but to many other curriculum areas including the social studies and the creative arts.

Materials

Many patterning activities do not require any materials at all (jumping, clapping, singing). However, most pattern activities are conducted with the use of commercial materials such as small blocks or beads.

* List five patterning materials you can find at your center.

  1.

  2.

  3.

  4.

  5.

* Consult a few school supply catalogs. What other two commercial materials would you buy? Why?

  1.

  2.

Many pattern activities can be carried out (planned or spontaneously) using materials in the home or child care center not specifically designed for patterning. One example is the set of unit blocks.

* List five materials found at home or at school children could use to build patterns.

1.

2.

3.

4.

5.

Planned Small-Group Activities

It is the teacher's responsibility to provide varied materials to encourage the development of pattern recognition and, later, of pattern creation. In addition to the materials, which should be attractive and interesting, the teacher needs to provide models (pattern cards) or model the pattern herself to encourage copying. With older children, the teacher will present opportunities for interpolation and extrapolation.

* Describe a planned small-group activity with patterns for three-year-olds. Now describe how you would present the same activity for older four-year-olds and five-year-olds.

1. Young preschoolers:

2. Older preschoolers:

Incidental Learning

Children will encounter many opportunities to recognize, imitate, and create patterns during free play and non-math group times. The teacher will have the opportunity to encourage patterning during circle time, at the manipulatives table, during music time, and so on.

* Describe a way you could encourage patterning in the block area.

* Describe how you could encourage patterning in the art area.

Activities for Parents

Parents need to be aware of the importance of the patterning concept in the cognitive development of their children. Frequent suggestions of patterning activities will help parents to foster this idea.

* Describe one patterning activity parents can do with their children at home.

Extending Yourself

* Design a book on pattern for preschoolers. Write a brief outline of the text and describe briefly the illustrations.

Books for Children

Charosh, M. Number Ideas Through Pictures. New York: Thomas Y. Crowell Co., 1974.

Hoban, T. Look Again! New York: Macmillan Publishing Co., Inc., 1971.

Songs

Software

7. FRACTIONS

In common language, fraction is used to designate some unspecified part of a whole. For example: "Only a fraction of the parents came to the meeting." The idea of part of something is the key idea here. Children acquire this concept early. They have an intuitive grasp of the fraction concept. One-half means to the young child that something has been separated in two parts regardless of the size of each part.

Children at this state (three- and four-year-olds) are ready for a simple introduction to the meaning of halves, thirds, and fourths. The key concept that will be developed is the equivalence of the parts.

Children will understand the importance of "equal size pieces" if it is related to their experience in receiving a fair share. For example, if a candy bar is cut into two unequal pieces, it makes a difference which piece you choose. The "you cut, I choose" method will help reinforce the need for cutting into equal size pieces to get a fair share.

* Observe - During mealtimes, observe instances in which children share. Briefly describe. Did any talk about equal size/equal amount occur?

The Teacher's Role

Much emphasis must be placed on equal size pieces. Children need to be able to recognize equal size pieces and differentiate this from unequal parts of a whole. They also need practice in producing equal size pieces of a whole through folding or cutting. The teacher will provide activities and suggestions in order for the children to develop an accurate fraction concept. When a child can identify the unit, can tell the number of pieces in a unit, and can decide whether those pieces are of equal size, she is ready for naming fractions. Preschool children learn very early to use the term half. Later they may be introduced to thirds, fourths, and fifths. Although teacher and children will explore the naming of fractions, mastery in this area should not be expected. This will happen later during the elementary school years.

Materials

Commercially made materials for the teaching of fractions are usually too abstract and complex for the preschool child. Some fraction material can be adapted for use with young children and other mathematical materials may be used to illustrate the fractional number concept. Among the latter, the Cuisenaire rods and the pattern blocks are exceptionally useful.

* Can you find two commercially made materials to teach fractions in your center?

1.

2.

* Look through a few school supply catalogs. Find one fraction material appropriate for preschoolers and describe how you would use it in small-group work.

Children will also be able to experience fractions with a number of teacher-made materials or by experimenting with commonly found materials such as clay, playdough, paper, or cardboard.

* Design a game that deals with fractions and is appropriate for three- and four-year-olds. Describe briefly.

Planned Small-Group Activities

Small-group work on fractions will focus on the materials provided by the teacher and will be the opportunity for the development of fractional language.

* Describe a fractional activity using Cuisenaire rods.

Incidental Learning

Free play, cooking projects, and daily routines are some of the occasions where incidental learning about fractions might occur.

* Describe how children may learn about fractions during cooking projects.

Activities for Parents

* Suggest one activity dealing with fractions that parents could do with their children during dinnertime.

Extending Yourself

* Find out how the Montessori method teaches fractions to children under five.

Books for Children

Lionni, L. Pezzetino. New York: Pantheon Books, Inc., 1975.

Songs

Software

8. MEASUREMENT

Measurement is the process of assigning a number to a set or object; the measurement is the number actually assigned. Work with measurement is practical and inherently motivating to children since it involves learning about themselves and the world around them.

There are six basic properties of objects that children should learn to measure. They are listed below roughly in the sequence that children acquire the ability to learn them:

1. Length
2. Area
3. Volume and Capacity
4. Weight and Mass
5. Time
6. Temperature

Measurement involves the use of number in a continuous sense; therefore it is more difficult than counting. For example, "There are three trucks on the shelf," is a simpler idea than, "The shelf is three feet long." Comparison, sequencing, and estimation are the skills involved in measuring.

Learing about measurement starts with comparisons, progresses through measuring with arbitrary units, and becomes functional when children understand the meaning of standard units. Younger children will limit their measuring experiences to establishing which is big and which is small, long or short, fat or skinny, and so on. Older three-year-olds and four-year-olds will begin to measure objects

using an arbitrary unit such as a new pencil, a foot shape, toothpicks, or tongue depressors. It will not be until kindergarten or even later that children will be able to measure consistently with standard units.

* Observe - Listen to children's conversations during play. Record two instances in which measurement terminology was used (comparison or estimation of length, area, or capacity).

  1.

  2.

The Teacher's Role

Skills in measurement are important throughout one's life. Young children should be actively involved in the processes of measurement. Steps in teaching measurement concepts and skills begin when children make informal comparisons of objects. Terminology such as "larger than," "smaller than," "the same size as," "heavier than," and so on, should be introduced early. Older preschoolers should start measuring with nonstandard (arbitrary) units. In this step, they actually assign a number or a measure to a set or object. Children may measure length by placing pencils or tongue depressors end to end, capacity with beans or rice, and weight with washers or blocks. Also, the teacher might model and discuss the need for a standard unit of measurement after children become experienced with nonstandard units.

However, a full understanding of the measurement concept cannot be expected during the preschool years.

Materials

Most commercial measurement materials are designed for older children and are not appropriate for the preschooler. A few materials, however, are valuable and will enhance the acquisition of a measurement concept. Among these, the teacher will find that the balance or scale, the timer, and a yard (or meter) stick are essential.

* Describe one measurement apparatus or game that you would buy for children under five.

Many useful materials for teaching measurement can be found in the environment or they can be acquired inexpensively.

* Which materials would you use to demonstrate measuring with nonstandard units? Name three.

1.

2.

3.

Planned Small-Group Activities

Small-group work is especially useful to provide measuring experiences for young children. For example, repeated work with

nonstandard units done by different children measuring the same object and obtaining different results, will eventually convey to the children the need for a standard unit.

* Briefly describe three measuring activities for small-group time.

1.

2.

3.

Incidental Learning

The teacher will find many opportunities to encourage the development of measuring skills during the daily routines, free play, and during some activities that are not strictly mathematical.

* How can you encourage measuring in activities designed to increase self-esteem, such as "Learning about myself"?

* How can you encourage measuring during block play?

Activities for Parents

* Suggest one activity that parents can carry out with their children to develop an understanding of measurement.

Extending Yourself

* Write a short story for preschoolers in which measuring plays an important part.

Books for Children

Andersen, H.C. Thumbelina (many editions).

Fey, J. T. Long, Short, High, Low, Thin, Wide. New York: Thomas Y. Crowell Co., 1971.

Hoban, T. Big Ones, Little Ones. New York: Greenwillow Books, 1976.

Lionni, L. Inch by Inch. New York: Astor Honor, Inc., 1962.

Myller, R. How Big is a Foot? New York: Atheneum Publishers, 1972.

Tresselt, A. How Far is Far? New York: Parents' Magazine Press, 1964.

Songs

"Rock-a-my-soul"

Software

A few words about ....

Time

One of the most difficult concepts for young children is the passage of time, yet it is one of the instances in which they are constantly confronted with standard units (days, hours, minutes, seconds).

Time cannot be seen nor can it be measured directly, and since young children live in the present, time has a psychological quality for them. Time is defined, not by duration, but by the emotional quality of it (good time, fun time, terrible time) or by the activity that normally occurs at that time (lunch time, nap time, circle time, time for bed).

Early experiences which introduce ideas such as "before," "after," "how long," "how soon," help children acquire the notion of the passage of time and its measurement. The concept of time is made even more complex given time's role in the young child's idea of the relationship of size and chronological age.

Initially, the introduction of a regular daily routine helps in building the early understanding of time. Only later will the clock movement begin to acquire meaning for the child.

The Days of the Week

As in counting, children may know the days of the week in a rote fashion. Preschoolers will eventually memorize the seven names in the correct sequence, but a rational understanding of the week will be achieved only through the experiencing of determined activities consistently linked to the same day of the week.

The Seasons

It is very doubtful whether young children see the significance or even remember the previous season. Nevertheless, children's books and traditional preschool teaching practice often explore this concept. Probably, the learning will be limited to the rote recitation of the seasons' names in correct order. Holidays and birthdays are more salient concepts for children and help them understand gradually the larger sequence of the succession of years. Most young children are able to answer the question "How old are you?" but only a few children can answer the next question: "Four what?" or "How many birthdays have you had before?"

Time concepts can be explored through questions such as "How long will it take?" asked during a cooking project or by setting a timer for five minutes, at first, during block play and later for ten minutes, for example. Encourage the child to compare the structure he built during the first interval with that completed in the second instance.

Time may be measured in arbitrary and concrete ways at first (sand or water running through a small hole in a bucket, for example). Teachers will also provide opportunities for children to order pictures of events that occur in time (getting up, washing face, etc.), integrate time and music (fast rhythms, slow rhythms), and develop a sense of duration.

Telling time is a skill reserved for older children.

Books for Children

Behn, H. All Kinds of Time. New York: Harcourt, Brace and World, Inc., 1950.

Bendick, J. The First Book of Time. New York: Franklin Watts, Inc., 1963.

Brown, M. W. A Child's Good Night Book. New York: William R. Scott, Inc., 1943.

Brown, M. W. Night and Day. New York: Harper and Brothers, 1942.

Goudey, A. E. The Day We Saw the Sun Come Up. New York: Charles Scribner's Sons, 1961.

Spier, P. The Fox Went Out on a Chilly Night. New York: Doubleday and Company, 1961.

Treasalt, A. Wake Up Farm. New York: Lothrop, Lee and Shepard Co., 1955.

9. PROBLEM SOLVING

Problem solving is an ability critical to human progress and it is one of the most important aspects of mathematics. Mathematical problem solving helps children develop their analytical thinking processes and enhances the learning of mathematical facts, concepts, principles, and skills. When problem solving is ignored in early instruction of mathematics, the mathematics learned is likely to consist of memorization of number names and rote counting rather than conceptual learning.

Young children can learn basic problem-solving processes, if they are given the appropriate experiences. They should be encouraged and guided to find solutions to problems within their world of experience relating to all areas, not only those of a mathematical nature. The cognitive processes involved in problem solving are:

1. Classification
2. Deduction
3. Estimation
4. Pattern Generation
5. Hypothesizing
6. Translation
7. Trial-and-Error
8. Verification

Word problems are poor tools for teaching these eight problem-solving processes to young children. Because the word problem is abstract, it is usually too difficult for most children. On the

other hand, if the problem consists of concrete components, young children are capable of mastering all of the mentioned processes.

* Observe - Describe two instances in which a teacher encouraged children to solve a problem (mathematical or nonmathematical). List some of the problem-solving processes involved.

1.

2.

The Teacher's Role

Problem solving should be a pervading attitude throughout the child's day at the center. It will happen during free play in social interactions, in the sand box, the block area; even riding a tricycle will present a child with occasional problems that need to be solved. The perceptive teacher will encourage children to engage in problem solving, providing only the support and the necessary techniques, not the solutions.

In the area of early mathematical instruction, the teacher will foster problem solving in two different manners. First, the teacher

will ask children to solve problems during all small-group sessions. The teacher will ask questions, set up a problem, or take advantage of a spontaneous situation while working with the children on such topics as counting, patterns, spatial concepts, and so on. Second, the teacher will plan problem-solving activities designed to foster the development of one or more processes.

When choosing or designing a problem-solving activity for young children, teachers should be aware of the problem-solving processes that the specific problem will require a child to exercise. Also, good problems for young children should:

- Be easily comprehensible and easily related to their world of reality.
- Capture their interest. Children should be attracted by the nature of the materials, the situation itself, the transformation that they impose on the materials, or some combination of these factors.
- Require several steps to a solution. This causes children to organize, reflect, take wrong turns, make corrections, and eventually arrive at a satisfactory solution.

Problem solving is of such basic importance in early childhood that the selection and design of <u>good</u> problems is worth any amount of creative energy that teachers can devote to them.

Finally, it is an important responsibility of the early childhood teacher to foster a positive attitude toward problem solving. The teacher will listen to the child's reasoning and value it more than

a correct answer. A teacher will encourage and support creative problem solving and will ask about the reasons for the child's solution. The teacher's interest in the children's thinking will be more rewarding to them than the stereotyped praise for correct solutions. It will also make math teaching more interesting because it will give the adult clear insights into young children's thought processes.

Materials

There is no specific equipment developed just for problem solving but many of the mathematical learning materials lend themselves to problem solving.

* Name five mathematical materials (commercial or other) suited for problem-solving activities.

1.

2.

3.

4.

5.

Planned Small-Group Activities

If the purpose of the small-group math session is problem solving, the teacher needs to decide if the group will work cooperatively on one problem with one set of materials or if they will work individually on one problem, each child with her own materials. Both approaches are equally valid and the decision will often depend on the availability of the materials.

* Describe two problem-solving activities for each age group.

Two-year-olds:

1.

2.

Three-year-olds:

1.

2.

Four-year-olds:

1.

2.

Incidental Learning

As pointed out before, problem solving occurs throughout the day in all areas of the center. In the block area, children decide how their structures should look and then they are presented with

the problem of how to make their plan work. Mostly they will arrive at a solution through trial-and-error. The adult can refine the processes involved by asking a child to hypothesize or estimate, for example. The manipulatives table is another area rich in opportunities that foster children's problem-solving skills while activities such as cooking or art provide numerous examples of good problems.

* Look at three activity areas in your center. Describe one problem-solving activity that you can set up or support for each one of these areas.

  1.

  2.

  3.

Activities for Parents

Parents might not be aware of the numerous problem solving opportunities in their child's day. Also, they might tend to believe that preschoolers are too young for problem solving and they might often provide the child with ready-made solutions. It is the teacher's responsibility to remind parents of the importance of nurturing early problem-solving skills. It will help parents if the

teacher provides suggestions for activities that can be accomplished during routine times at home (dressing, bathing, driving to school, and so on).

* You are trying to convince parents that young children engage in problem solving every day. Write a short paragraph in which you list children's spontaneous problem solving at home: alone, with siblings, and/or with parents.

Extending Yourself

* Familiarize yourself with the computer software written for young children found in your center. Describe how it can be used in stimulating young children's problem-solving processes. Disregard drill-and-practice exercises.

Books for Children

Allen, R. and Garfunkle, B. Numbers. New York: Platt and Munk, 1968.

Taboriu, G. Norman Rockwell's Counting Book. New York: Harmony Books, 1977.

Wailes, J. R. and Westerberg, V. M. Fingerplays, Rhyme and Riddle for Young Children. Boulder, CO: Media Workshop, 1974.

Klein, S. An Elephant in My Bed. Chicago: Follet Publishing Co., 1974.

Shapier, F. Round and Round and Square. New York: Abeland Schuman, 1965.

Peppe, R. Odd One Out. New York: The Viking Press, 1974.

Songs

Singing games that require the child to come up with an idea or perform an original action provide good problem-solving opportunities: "Little Johnny Brown, lay your confort down . . . ," "The rain will get the . . . wet . . .," and so on.

Software

Micro Mother Goose

Face Maker (Spinnaker)

Gertrude's Puzzles (The Learning Company)

10. SPACE AND SHAPES

Children discover space the day they are born. A two-year-old has already had considerable experience in exploring space through thrashing about in a crib as an infant, crawling toward objects, and walking as a toddler. And all the time children discover space as they play with their toys. They discover that some things are close while others are far away; they find out about boundaries and how some things belong inside these boundaries, and while others may cross them.

Children's early spatial concept development is topological. Topology is the study of space concerned with position or location, where shape and length may be altered without affecting the figure's basic properties of being open or closed. To understand the difference in topology and Euclidean geometry, consider a rubber band placed in the shape of a square. It can be changed by stretching to make other shapes (triangles, circles, etc., or even irregular shapes) which are topologically equivalent but different Euclidean figures.

If a young child is shown a triangle and asked to make several copies of it, he will likely draw several simple closed curves but not necessarily triangles. To the child, all of his drawings look the same because he perceives only the triangle's property of being closed. In fact, his drawings are topologically equivalent.

Children who perceive the world topologically are developing four basic relationships:

1. Is close to - Is far from
2. Is part of - Is not part of

3. Comes before - Comes after

4. Is inside of - Is outside of - Is on

Young children explore topological space when they play with blocks or bricks and build rooms in which people are placed, garages in which cars are kept, beds in which dolls will sleep.

Between the ages of five and seven, most children develop the ability to understand the meaning of Euclidean space. Euclidean geometry involves the idea of fixed shape, size, length of sides, number of sides, and numbers of angles. This is the geometry adults are most familiar with.

* Observe children's play in the block area. Record words or phrases that refer to topological space on one side of the page and those dealing with Euclidean space on the other.

Topological	Euclidean

The Teacher's Role

The teacher will encourage children to build and talk about their buildings, for example, in order to encourage the understanding of topological space. Children will use language that denotes aspects of space such as position (up, under, inside), volume (full, huge), order (before, between, after), and comparison (larger, shorter, bigger). Bodily movements provide experiences that help children

explore and define space. Children will be asked to reach as high as possible, out as far as possible, and soon. Children will become as small as possible, then as large as possible. Through their physical activities, children develop an understanding of the dimensions of their space.

As they grow older, preschoolers begin to understand the more abstract ideas of Euclidean geometry. The teaching sequence for Euclidean concepts starts with activities dealing with two-dimensional shapes. The teacher will ask children:

- To match shapes without naming them
- To recognize a shape when identified by the teacher
- To identify a shape when shown by the teacher
- To draw shapes.

Children will use terms such as straight, curved or rounded, point, or angle, or corner, and the name of the shape under discussion. After children become familiar with basic two-dimensional shapes, they are ready to explore three-dimensional shapes and find out how the different solids behave (will it roll, can you stand it upside-down, and so on) and observe similarities and differences. They will learn the geometric terms of sphere, cube, cylinder, prism, and pyramid. They will explore the flat surfaces and relate them to two-dimensional shapes. They will talk about faces (the flat surfaces of the polyhedra) and see that the <u>faces</u> meet along <u>edges</u> and that the edges meet at the <u>corners</u>.

The teacher will also introduce two important spatial concepts: <u>symmetry</u> and <u>perspective</u>. Ideas of symmetry will be developed

through experiences in folding, pattern making and play with mirrors. To convey the idea of perspective the teacher will encourage children to become aware of how our view of people and objects is constantly changing as we and the things about us move.

Materials

Appropriate materials to encourage the development of spatial thinking are abundant in any well-equipped child care center. There are also many materials specifically designed to teach Euclidean geometry concepts. These materials are often used to teach other concepts such as classification or patterning. Attribute Blocks and Pattern Blocks are examples of versatile geometric materials.

* List two commercial materials found at your center that can be used to explore topological concepts.

  1.

  2.

* List two commercial materials found at your center that can be used to explore Euclidean geometry concepts.

  1.

  2.

* Look through one or two school supply catalogs and find one geometrical apparatus that you would recommend your director buy. Why?

* Describe one game that you could make or assemble that would help children understand a space or shape concept.

Planned Small-Group Activities

Planned activities will help children learn the necessary vocabulary concerning space and shapes while they manipulate geometric materials. It will permit the teacher to demonstrate the properties of topological space and the characteristics of two- and three-dimensional shapes. Some children will benefit from some coaxing to explore ways of employing materials not familiar to them such as pattern and parquetry blocks.

* Describe one structured activity dealing with topological space.

* Describe one structured activity for three-year-olds dealing with Euclidean geometry.

Incidental Learning

All activity areas of your center and many routine times will provide rich opportunities for incidental learning of spatial concepts. Active play time in the yard is an excellent time for children to experience space through total body involvement. Catching, throwing, and aiming beanbags at a target are other activities that lend themselves to the encouragement of spatial thinking.

* Observe a movement/dance session at your center and record briefly the instances in which children experienced topological space.

* How do children explore space (topological or Euclidean) in the sandbox? In the art area?

1.

2.

Activities for Parents

Although most parents are very interested in teaching their young children about Euclidean geometric shapes (square, circle, and so on), few are aware of the importance of topological space concepts in the cognitive development of the preschooler. Therefore, when suggesting topological activities for the home, the teacher will need to provide parents with a brief explanation of the basic topological relationships.

Parents of the older preschooler need to expand their geometric activities to include the three-dimensional solids and their relationship to two-dimensional shapes.

* Suggest one simple activity that parents can do at home with their four-and-a-half-year-old to enrich her understanding of three-dimensional solids.

Extending Yourself

* Compare the drawings of several three-year-olds to the drawings of older preschoolers (four- and five-year-olds). Note how the four basic topological relationships are visually presented.

Books for Children

Berenstain, S. and Berenstain J. Inside, Outside, Upside, Down. New York: Randon House, Inc., 1968.

Hoban, T. Over, Under and Through and Other Spatial Concepts. New York: Macmillan Publishing Co., 1973.

Klein, S. An Elephant in My Bed. Chicago: Follet Publishing Co., 1974.

Shapes

Carle, E. My Very First Book of Shapes. New York: Thomas Y. Crowell Co., 1974.

Hoban, T. Shapes and Things. New York: Macmillan Publishing Co., 1971.

Hutchins, P. Changes, Changes. New York: Macmillan Publishing Co., 1973.

Pienkowski, J. Shapes. New York: Harvey House Publishers, 1975.

Ungerer, T. Snail, Where are You? New York: Harper and Row, 1962.

Songs

Bluebird, Bluebird ...

Duck, Duck, Goose

Hokey, Pokey

Software

Sticky Bear Shapes (Xerox)

Sticky Bear Opposites (Xerox)

Juggle's Rainbow (The Learning Company)

A few words about ....

Evaluation

Evaluation is a multifaceted process. It involves determining the amount and quality of children's growth. It involves knowing the objectives of the mathematics program. It requires teachers to know and to understand children. Evaluation is an integral part of daily instruction for a teacher needs to know where children are in their cognitive development and mathematical knowledge.

Evaluating is gathering information about children using many available techniques. Teacher observation is the most appropriate technique for the evaluation of young children's mathematical learning. Recording is a way of keeping the information once gathered. Teachers may develop different ways of recording children's progress but it is very important that some systematic record keeping procedure be employed. A sample record-keeping form follows on page 80.

Parents and teachers need to communicate about children's growth and progress. Parents of young children are particularly interested in hearing about their child's activities at the center. Besides conferences in which the Progress Record might be discussed, parents enjoy receiving samples of their child's work or notes about his or her special achievement.

EARLY MATHEMATICAL EXPERIENCES

PROGRESS REPORT

Place a check or a sticker in box when the child has acquired the concept.

Name: _____

Date: _____

Compares objects using quantitative terms such as "heavier than," "longer than."	Observes and describes objects in the environment.	Copies patterns. Recognizes patterns. Creates patterns.	Identifies ordinal number of an element in a series. Determines cardinal number of a set.	Understands topological concepts: proximity ____ open/closed ____ inside/outside ____ before/after ____
Classifies objects: Follows adult directions: ____ Invents own classification system: ____	Orders objects. Orders events in time.	Reads numerals. Writes numerals.	Measures with arbitrary units. Measures with standard units.	Names two-dimensional shapes. Names three-dimensional shapes.
Puts sets into one-to-one correspondence.	Rote counts. Counts rationally.	Addition to a total of 10. Subtraction.	Understands fractions: half ____ one-third ____ one-fourth ____	Understands and solves appropriate word problems.

RESOURCES FOR TEACHERS OF EARLY CHILDHOOD MATHEMATICS

Barata-Lorton, M. Workjobs II. Number Activities for Early Childhood. Menlo Park, CA: Addison-Wesley Publishing Company, 1979.

Barron, L. Mathematics Experiences for the Early Childhood Years. Columbus, Ohio: Charles E. Merrill Publishing Company, 1979.

Cruikshank, D. E., Fitzgerald, D. L. and Jensen, L. R. Young Children Learning Mathematics. Boston: Allyn and Bacon, Inc., 1980.

Green, R. T. and Laxon, V. J. Entering the World of Number. A Step-by-Step Guide for Parents. New York: Thames and Hudson, 1978.

Maffei, A. C. and Buckley, P. Teaching Preschool Math. Foundations and Activities. New York: Human Sciences Press, 1980.

Matthews, G. and Matthews, J. Early Mathematical Experiences. London: Addison-Wesley Publishers Limited, 1982.

Payne, J. N. (Ed.) Mathematics Learning in Early Childhood. 37th Yearbook of the National Council of Teachers of Mathematics. Reston, Virginia, 1975.

Young, S. Mathematics in Children's Books. An Annotated Bibliography Preschool Through Grade 3. Palo Alto, CA: Creative Publications, 1979.

Zaslavsky, C. Preparing Young Children for Math. A Book of Games. New York: Schocken Books, 1979.

APPENDIX H

Activity File

CLASSIFICATION

Sort-It-Out

The child is challenged to sort ordinary objects according to different criteria. The younger child will sort for color, size, or shape, perhaps by putting colored buttons into egg cartons. The older child will be able to take on more complicated sorting tasks, such as separating items after a shopping trip according to "what goes in the refrigerator, what goes in the cupboard, what goes in the cleaning closet, etc." Putting pennies, dimes, nickels and quarters into different containers is a game particularly enjoyed by young children.

Observations

These activities are good suggestions for parents.

CLASSIFICATION

Name Another

Choose a category, like things to eat, things that have wheels, things that go in the water, things that are not found in houses, animals that live in the zoo, transportation, or things that keep us warm. Take turns with children naming things that belong to that category.

Observations

A good game to play at home or in the car.

CLASSIFICATION

Intersecting Sets

Position two loops of yarn on a table. From a collection of attribute blocks begin to form two sets of objects, building each set within one of the circular areas, perhaps "red" and "triangles." As you take each object from the collection, have the children assign it to one of the sets. When they are sure of the procedure, produce a red triangle and ask them where it should go. They will agree that it is both red and a triangle. Let the children find their own solution to where the block should go. Do not provide a solution at this time; the important concept to be learned is that an object can be a member of more than one set.

Observations

CLASSIFICATION

All Sorts of Counters

You need a box or tub with an assortment of buttons, screws, blocks, sticks, stones, spools, clothespins, and so on. You also need a number of juice cans or margarine containers.

Ask the child to sort things that go together and put them in the different containers. Talk about why they decide to group things the way they do. You can also ask the child or children to count the objects in the different containers.

Observations

CLASSIFICATION

Button Box

You need a good assortment of buttons. You may ask the children in your center to contribute five or more buttons to the box. Provide the children with sorting trays or empty egg cartons.

Help the children notice the differences between sizes, shapes, colors, texture, and number of holes. Allow the children to play and explore as they please. Later ask them to sort the buttons finding buttons that go together.

Observations

This is a good activity for parents to try at home with their children.

ORDERING

Hidden Objects

You will need a set of Cuisenaire rods (or a similar graded material).

Place three rods of different lengths in the feely bag. Ask the child to reach in and remove the shortest rod. Replace that rod and ask for the longest rod. Replace and ask for the middle-sized rod. Take out the rods and talk about the child's choices. Repeat the activity with more rods in five, and later more, sizes.

Observations

ORDERING

Sequencing Events in Time

You will need a set of sequencing cards depicting events which evolve in time (a tree growing from a seed, the building and melting of a snowman, etc.).

Ask the children to look at the cards and decide what happened first, what came next, and so on. Encourage conversation by asking questions: "What makes you pick this card? How can you tell that this comes next?"

Observations

ORDERING

Sandpaper

Obtain five or six sheets of sandpaper in varying degrees of coarseness. Cut each sheet in four pieces and make four sets of sandpaper squares.

Ask the children to order the squares from coarse to fine.

Observations

ORDERING

Full and Empty

Fill several baby food jars or other containers with rice in different amounts and ask the group to order them from empty to full or vice versa. After arranging the jars you may want to pour out all the rice and have children refill the containers. Ask children to arrange the jars again.

Observations

ORDERING

Which Comes First?

Groups of items of various sizes (blocks, pencils, sticks, pebbles, books) are needed.

Ask the children to work together and decide which comes first. Children may decide the smallest, shortest, etc., comes first or the tallest, longest, etc. Let the children work with minimal adult intervention until they agree they have the desired sequence. Talk about the result but don't impose your sequence. Repeat this activity with the same or, better yet, with other objects. In another session use structured sequencing materials and then use environmental objects again.

Observations

ORDERING

The Three Bears

You will need a large flannelboard and the following felt figures: table; small, medium and large bowls; chairs; beds; Goldilocks; and small, medium and large bears.

Tell the story first and place the proper figures on the board at the proper time. Retell the story and let some helpers place the figures at the proper time. Also, let the children match small bear with small bed, etc.

Observations

PATTERNING

Patterns with Counters

You will need several 4 x 6 index cards and any kind of counters you choose.

Place the index cards in a linear arrangement and begin a pattern with the counters by placing one counter on the first card, three on the second, one on the third, three on the fourth, etc. Ask the child to put counters on the next card. "How do you know how many to put there? Why did you use that many counters?"

Observations

PATTERNING

Matching Patterns

Provide several squares of wallpaper and analyze the pattern (blue stripe, red stripe, blue stripe, red stripe).

Provide two squares of each pattern and have children find the matching ones.

Repeat the activity with fabric scraps. Involve the families by asking each child to bring a patterned fabric or paper scrap from home.

Observations

PATTERNING

Copying Patterns

You will need an assortment of beans, buttons, bottlecaps, washers, milktops, pebbles (in short, you need a Stuff Box).

Make a pattern and have children copy it. Then have one of the children make a pattern and everybody copies it, and so on until everybody had a turn creating a pattern.

Observations

Keep your patterns very simple (bottlecap up, cap down, cap up, cap down; or milktop, two buttons, milktop, two buttons) until the children clearly understand the pattern concept.

PATTERNING

Involving the Whole Child in Patterns

1. Teacher claps hands and touches head; children join in as they recognize the pattern. Stop and start with a new pattern.

2. Teacher places first few children (one child stands, one child sits, one child stands, one child sits). Additional children join the row and continue the pattern.

3. Children reproduce a pattern they hear with Unifix cubes (red, blue, blue, red, blue, blue).

Observations

PATTERNING

What Comes Next?

Draw (or use manipulative shapes) the first four figures of a pattern (square, triangle, square, triangle; or circle, square, circle, square; or small triangle, large triangle, small triangle, large triangle, etc.) and ask the child or children to finish the line.

Observations

Good suggestion for parents. At home small and large buttons may be used (or pennies and nickels, or two kinds of pasta or beans, and so on).

PATTERNING

Matching Bead Patterns

You will need a tub of beads in different shapes and colors and cards with a bead pattern on each. These cards are commercially available or you can make them yourself. You also need several long shoelaces.

Encourage the children to choose a card and copy the pattern by stringing the beads in correct order.

Observations

PATTERNING

Teddy Bear Patterns

Make pattern cards on strips of heavy paper. Draw colored circles in a pattern, for example: one blue, two red, one blue, two red.

Children will pick a pattern card and place teddy bear counters on the circles and then continue the pattern independently.

Observations

ONE-TO-ONE CORRESPONDENCE

Cups and Sticks

You will need six to eight cups and eight to ten tongue depressors or popsicle sticls.

Make a row of cups and ask one child to put one stick in each cup. Then take the sticks and lay them end to end in front of the row of cups. Ask: "Are there still as many sticks as cups?"

Observations

In this activity some children will say that there are more sticks than cups because the line of sticks is longer than the row of cups. Do not correct the child. Ask the child to place the sticks back in the cups and ask the same question again. Allow the child to figure it out by herself.

ONE-TO-ONE CORRESPONDENCE

People and Pennies

You will need several toy people and lots of pennies.

Make a row of eight or nine toy people. Ask a child to give each toy person one penny taken from a container with ten pennies or so. Ask the children if there are more pennies than people. Change the number of pennies or people to obtain different results. In the instances where equivalent sets are obtained, put the pennies back into the container and ask the children: "Is there still one penny for each person?" Ask one child to prove her answer by reestablishing the original one-to-one match.

Observations

ONE-TO-ONE CORRESPONDENCE

Beans and Dots

Use heavy construction paper or cardboard to make a board divided in ten sections. Begin placing no dot in the first section, one dot in the second, and so on until the last block has nine dots on it. Make one board for each child in your group. Supply children with beans and ask them to put the same number of beans in the block as dots. As the children play this game, use number names in your questions. For example, say "Did you cover all four of the dots with beans? Can you cover the seven dots with beans?"

Observations

ONE-TO-ONE CORRESPONDENCE

Musical Chairs

For young children the rules of the game must be modified so that no one will be eliminated. Children usually prefer to play Musical Chairs with as many chairs as children. Children can decide how they want to play the game, with the same number of chairs as children, or with one or more chairs fewer (but without eliminating those children who did not get a chair). All of these variations are good for the quantification of objects and one-to-one correspondence.

Observations

Keep the number of players small. Let children arrange the chairs and decide when they have gotten the desired number.

ONE-TO-ONE CORRESPONDENCE

Number Bingo

You will need to make up to six tagboard cards (8" x 11") divided in fourths. Draw from one to six red circles in each section. Cover with contact paper. Also, you need counters and a die with dots and a die with numerals.

Up to six children can play the number bingo at one time. Children will take turns to throw the dice. If the child has the number of dots indicated by the die, she will cover the dots with counters. The first child to have all the dots covered ends the game. After the children have had experience with numerals, they will find the numeral die more challenging.

Observations

ADDITION

Addition with Cuisenaire Rods

You will need a set of Cuisenaire rods for each child.

Ask the children to find single rods that are equal, the same length as a train of two or more rods. Children must find the black rod to match the train of green and purple, and so on. Allow enough time for children to explore and discover relationships.

Observations

ADDITION

Hiding Game

This game is played with tongue depressors. After showing six sticks, for example, to the children, the teacher hides all of them under the table with both hands, and then brings four out in one hand. She then asks, "How many do you think are in my hand under the table?"

Observations

ADDITION AND SUBTRACTION

Bead Stringing

You will need a box of beads and several shoelaces, one for each child in your group.

Ask the children to string a number of red beads on their shoelace and then ask them to add a number of green beads, for example. Ask the children to count how many beads they have all together. Use different combinations. Then ask them to remove a number of beads and, again, ask them to count the beads to see how many they have left.

Observations

ADDITION AND SUBTRACTION

The Shark

You will need fish crackers and blue oceans (a sheet of blue construction paper for each child).

Please from zero to eight crackers in each ocean. Have each child tell you how many fish they need or will need to put back so each child starts with six. Tell the story of Jaws, the Shark, first requiring regrouping of fish. "Three swim to the top. Now how many are at the bottom? Two more swim to the top. How many at the top/bottom/whole sea? Now the shark swims by and gobbles up one of the fish at the bottom. How many are left?" Children eat one and answer: five. The shark goes away and two more fish come along . . . . Mix regrouping, addition, and subtraction.

Observations

ADDITION AND SUBTRACTION

Fox and Chickens

You will need several toy chickens.

Children are the farmers. The chickens are in the center of the table. While the farmers sleep (heads down), you, the fox, steal some of the chickens. Can the farmers figure out how many were stolen?

Observations

COUNTING: ORDINAL NUMBERS

Dog and Bones

Cut out a dog from felt. Cut out nine bones from a different color felt and write an ordinal number on each bone (1st through 9th).

Tell a story about how much a dog loves bones. After he collects some bones he likes to eat them in the correct order, first the one he found first, second the one he found second, and so on. Ask the children to help the dog by lining up his bones in the correct order.

Observations

You can design your own variations of this game in order to provide more practice for the children.

COUNTING: ORDINAL NUMBERS

Guess Which Cup?

You will need paper cups and shelled peanuts or raisins.

Please three cups (you will later increase the number of cups) numbered one to three on a table. Have one child hide her eyes while a peanut is hidden under one of the cups. Tell the child she has three guesses. Have the child open her eyes and guess which cup the peanut is under. The child must say, "The peanut is under the first, second, third cup," and not simply say "That one." If the child is correct she eats the peanut. Label and add more cups as the child learns more ordinal numbers.

Observations

COUNTING

Finger Counting

Help children learn the most efficient ways of finger counting. Sing or chant a numbers song and raise a finger for each number as you and the children sing. Ask the children, "Can you do this?" while you raise one or more fingers. "How many fingers are up?" Remember to include zero fingers. Practice counting together starting with zero. Also, count in reverse order bending fingers to zero.

Encourage subitizing (recognizing the number without having to count) up to five. Practice counting on from five, adding fingers of the other hand. Call out a number or show a numeral and ask the children to raise the appropriate number of fingers.

Observations

COUNTING

Feel How Many

Place several counters in a feely bag. Ask the child to reach in and feel how many objects are in the bag. This can be done by naming the number or by pointing to the appropriate numeral. Repeat the game with more or less objects.

Observations

COUNTING

Number Patterns

You will need a box of toothpicks.

Ask the children to make as many different arrangements as possible with two toothpicks. Talk about the arrangements. Repeat with three, then four toothpicks. If children become experienced with the procedure, you may want to have them glue the toothpicks on construction paper. Repeat the activity at another time using other materials such as buttons, dot stickers, etc.

Observations

COUNTING

The Concept of Zero

Collect several film containers. Place pennies in every container except one and close them. Ask the children if they can find the container with zero pennies without opening them. Try this with beans, rice, cotton, salt.

Observations

COUNTING

Tongue Depressor Sets

You will need several cups and about sixty tongue depressors.

Make sets of three and seven. Ask the children to make the sets that come between the two given sets. Repeat the activity several times using different given sets.

You may wish to use the same materials to ask children to make the set that comes before or after a given set.

Observations

COUNTING

Flannelboard Sets

You will need a flannelboard and flannelboard counting pieces.

Put a set of four to seven flannel pieces on the board and ask the children to make a set that "comes before" or a set that "comes after" the given set. If the given set has four objects in it, any set from zero to three is correct. Eventually the children should be encouraged to make the set that comes "just before."

Observations

COUNTING

Making Sets

You will need counters and small paper plates.

Have children form sets of two, for example, on several paper plates. Ask the children what is alike about all the sets (there are just as many in one set as in the others). Children must learn to name the numerosity "two" without having to count each time (subitizing). In the same manner, introduce one, three and four.

As an extention of this activity and when children truly understand these small numerosities, have children paste on sheets their collections of pictures showing one object, two objects, and so on. Staple the sheets together and make a "book." You may or may not decide to use the corresponding numerals.

Observations

COUNTING

Match Me

For each number one through ten, make a set of five cards with five different arrangements of dots representing that number.

Have the children match the cards with the same number of dots and/or substitute one card from one set with a card from another set. Ask the child, "Which card does not belong?"

Observations

COUNTING

Beans in a Jar

Use an empty clear glass jar. Put a random number of beans, between one and ten, in the jar. Ask the children to look at the beans and guess how many are in the jar. After every child in the group has had a turn to guess, empty out the beans and count the beans. Don't emphasize the correct answer too much. Encourage all childlren to make good guesses.

Observations

COUNTING

Clothespin Counting

Make five squares (later you may want to make five more) with zero to four dots on them. Use heavy cardboard for the cards. You will need a box of clothespins. Ask the child to pin the corresponding number of clothespins on each card.

Observations

After children become experts at matching dots and the equivalent number of pins, make a new set of cards with the numerals from zero to nine and repeat the activity.

COUNTING

Counting and Eating (raisins, fish crackers, peanuts, etc.)
Make five piles of raisins from one raisin to five raisins. Ask the child to count the number of items in each pile and after she counted them correctly allow her to eat them. Repeat a few times.

Observations

COUNTING

Lotto Number Game

Make one or more lotto board by ruling one 6" x 6" piece of cardboard into nine two-inch squares. Using dots, stickers or your own drawings create sets of up to five objects in each square. Cut nine two-inch squares for each board and write the appropriate numerals in each square. Ask the child or children to match the cards to the lotto board.

Observations

COUNTING

All Gone

Number of players: four to six. Vegetable or meat trays, counters, and a die are used in this game.

Starting with 20 pieces in each tray, players take turns throwing the die and taking that many pieces out. The person who empties his tray first is the winner.

Observations

COUNTING

Matching with Cards

You will need a deck of playing cards.

Lay out on a table or floor, playing cards one through ten. Place the rest of the cards (after removing the face cards) next to the ones spread. One or more children taking turns will try to match the top card from the deck with one of the displayed cards. Encourage counting of the spots on the cards and the reading of the corresponding numeral.

Observations

COUNTING

Apples in a Tree

You will need green, light brown, and red felt scraps. You will also need ten rectangles of white or light blue posterboard.

Cut ten tree tops from the green felt and ten tree trunks from the light brown felt. Glue them on the posterboard rectangles and write a numeral from one to nine on each trunk. Cut 45 "apples" from the red felt. Ask the children to place the correct number of applies on each apple tree.

Observations

COUNTING

Cottonball Game

You will need ten small squares of heavy paper, a drawstring bag, and a basket or ball of cottonballs.

The children take turns pulling a card from the bag, reading the numeral, and counting out the appropriate number of cottonballs. The game is over when all the cottonballs have been distributed. The children then count their cotton-balls.

Observations

You can substitute beans, counters, or any other object for the cottonballs.

COUNTING

Subitizing or Cluster Counting

Use a flannelboard which everybody can see and put felt objects on the board in clusters with a piece of yarn encircling the cluster.

Start with two felt objects, then three, then one. Have the children call out the number without counting. Later, work on four (two pairs) and five (three and two) until the children are able to perceive sets of four and five objects without counting in random arrangements.

Observations

COUNTING

Teddy Bear Counting

Make ten cards with numerals and the corresponding number of colored circles.

The children are to place the correct number of counters, matching the color of the circles, on each numbered card.

Observations

COUNTING

How Many are Missing?

You will need groups of like objects that are easily counted such as counting cubes, crayons, pennies, counters, etc.

Place group of objects on table where everyone can see and easily count them. Remove one or two objects while children close their eyes and ask, "How many are missing?" Children will learn to perceive small quantities quickly without the need of counting each item. Do not use more than five objects at a time.

Observations

COUNTING

Get Just Enough

You will need (a) paint brushes, toy people, cups, pen caps, markers, cowboys and cowgirls, and so on, and (b) seven paint containers, six trucks, four saucers, ten pens, a container for markers with seven empty places, twelve horses, and so on.

First show objects (b) for only a short time. Ask the children (who have not had enough time to count) to get enough of the matching objects (a). Discuss the difficulty they have. Then have them explain how to find out how many objects to bring (by counting).

Observations

COUNTING

Catch the Mistake and Make it Right

Have the children watch as you (or a puppet Mr. Mixup) make a counting mistake, such as failing to count an object, counting an object twice, errors in the verbal sequence, failure to maintain correspondence between verbal sequence and objects, reporting a number different from that applied to the last object.

Observations

This game will help childlren become aware of their counting strategies.

COUNTING

See It, Say It

Ask the children to make piles of blocks (up to five or six). Say a number or display a numeral and each child will point to the pile that has that many blocks. After the children become experienced at this game, let them take turns to call out the numbers or hold up a numeral.

Observations

COUNTING

Counting On with Unifix Cubes

Have the children count out a certain number of cubes and hide them under one hand. Give the children a few more cubes and ask them to verbalize the number hidden and count on to the total number of cubes. Repeat several times and keep the totals small.

Observations

COUNTING

Guess How Many?

Hide a few cubes in one hand and a few more in the other. Ask the children to guess how many you have in each hand. Keep the total constant for a while. Children will catch on to the idea of regrouping. Repeat with a different total.

Observations

COUNTING

Counting On and Counting Back

You will need small countable objects.

Have children count several objects, add one (later more). "How many now?" Add another, until they counted to ten. Start again with a different initial total. If children need assistance have a puppet, Mr. Knowsit, model the strategy: "Hmmm, here's four, one more makes five, one more makes six."

Have children count objects as they are placed in a box. "How many are in the box now?" Add one and let the children tell you. Check by counting.

Drop objects into a coffee can and have the children count by listening.

Observations

NUMERALS

Writing Numerals

You will need to make several dot outlines of each numeral on a sheet of paper or several different dot numerals on a sheet. You may want to Xerox the pages if you are working with a large group of children.

Ask the children to follow the dots.

Observations

NUMERALS

Writing in Sand or Cornmeal

Pour enough salt or cornmeal in a box lid or a cake pan to cover the bottom. The children trace numerals in the salt or cornmeal. Shake lightly to erase and start over. This activity should be repeated often.

Observations

NUMERALS

Dominoes with Numerals

Make a set of dominoes with numerals on one end and dots on the other. Tell the children that dots must be matched to corresponding numerals and numerals to the corresponding dots. Play the game as usual.

Observations

NUMERALS

Show Me

Make a set of "Show Me" numeral cards for each child. Put one of the numerals zero through nine on each card. Tell the children to hold up the correct numeral card when a set is displayed or when the oral name is given. "I am holding up some fingers. You pick the card that shows how many I am holding up. When I say 'Show me,' hold up your card." Repeat with questions that use the oral name. "I am going to say the name of a number. Hold up the card that goes with that number when I say 'Show me.'"

Observations

NUMERALS

Show Me the Dots

Make a set of "Show Me" dot cards for each child. Put a different number of dots on each card to represent the numbers zero through nine. Have the children respond to the written symbol for numbers and the oral names of numbers by holding up a card. "I am going to say a number name. When I do, you pick the correct dot card. When I say 'Show me,' hold it up." Repeat the question by holding up a numeral.

Observations

NUMERALS

Writing Numerals in the Air

Trace the numerals in the air, using the large muscles. Then have the children trace the same motion, making sure enough space is between children to avoid collision. Short descriptions help: one, straight down; two, around and back; three, around and around again; four, down and out, then cross it down; five, straight down and around, put the hat on top; six, down and around; seven, out and down; eight, down around one way and up the other; nine, around and down; zero, all the way around.

Observations

NUMERALS

Find-A-Number (or Numeral)

The adult traces and then cuts out (of flannel, construction paper, or cardboard) the numerals from zero to nine. It helps if there are two or more examples of each numeral. First the adult asks the child to pick a numeral at random and put it on the table or board. Then he tells the child the name of the numeral. After the child has learned to recognize the numerals, the adult can ask the child if she can pick out a zero or a seven. Later on the child can be encouraged to put the numerals in consecutive order.

Observations

This game can be played with magnetic numerals on the refrigerator, a good suggestion for parents.

NUMERALS

Egg Carton Game

You will need an empty egg carton (or many if you are working with a group), marbles, and a magic marker. Number the egg cartons from zero to eleven (with younger children you may want to explore only the first three or four numerals).

Ask children to put a marble in their egg cartons, close the top and shake. Children then place the egg carton on the table, open the top, and identify the numeral in the cup in which the marble has fallen.

Observations

FRACTIONS

Apples

Have apples for snack. Sit down with a small group of children. Cut one apple into two equal pieces, each called "half." Put the two pieces together to form a whole apple. Cut the apple in four pieces called "fourths." Cut another apple in "thirds." Again put the apple back together to show the children the "whole" apple.

If you serve bananas you can let one child cut the banana and another child chooses the part.

Observations

FRACTIONS

Fractions with Pattern Blocks

Many fractional relationships are discovered by manipulating the Pattern Blocks. If the parallelogram has the value of one, then the triangle is one-half, because two triangles make one parallelogram. Three triangles make a trapezoid. Three parallelograms make a hexagon. Two trapezoids make a hexagon.

Observations

FRACTIONS

Fractions with Cuisenaire Rods

You will need a set of Cuisenaire rods for each child.

After children had ample opportunity for free play with the rods, introduce the idea of fractions. Ask: "How many reds do you need to make one purple? Can you find two rods that make one red?"

Observations

MEASUREMENT

How Many Nails?

You will need a balance scale, several medium-sized nails, several small but dissimilar objects such as a toy car, a cork, a block, a ping-pong ball.

Ask children to balance the scale by placing an object in one pan and the appropriate number of nails in the other. Record the result, "Car -- five nails." After children have had some experience with this activity, ask them to estimate the weight of the object in nails. Repeat the activity some time later with additional objects.

Observations

MEASUREMENT

How Many Cupfuls?

You will need milk cartons (pint, quart, half-gallon), measuring cups, dry and/or wet pourable materials.

Open the top of the milk cartons. Ask the child to guess how many cupfuls will fill the container. Let her check by filling the container with that number of cups. If the cup is smaller (half-cup measure, for example), will it take more or less cupfuls? Reverse the procedure, starting with full containers and pouring the contents out in the measuring cups.

Observations

MEASUREMENT

Ready to Measure

You will need a box of toothpicks, clothespins, paper clips, or whatever material you may wish to use in measuring activities with non-standard units.

Ask children to measure different objects by placing toothpicks end to end. Measure a book, a pencil, a toy. Measure again with a different unit. Why are the results different? Ask children to estimate first and then measure. Encourage good guesses.

Observations

MEASUREMENT

Which is Heavier?

You will need a collection of objects whose weight and size seem disproportionate, such as washers, ping-pong balls, golf balls, balsa wood, hardwood, cotton, etc.

Ask children to guess by looking at two objects which one is heavier. Let them hold the objects and guess again. Later, they will use the balance and find out which one is heavier.

Take a walk around the classroom and identify two objects. Let children lift them, one at a time, and decide which is heavier (the red truck or the fire engine, the cardboard block or the wooden block, the elephant or the giraffe). Encourage children to describe how it feels to lift a heavy object, a light object, etc.

Observations

Repeat the walk in the yard.

MEASUREMENT

The Giant and the Elf

You will need several cutouts of large feet and several of small feet.

Tell the children the story: "In Never-Never Land there lives a giant who has a funny way of measuring his land. He goes heel-to-toe along. In the same land there also lives an elf, who always does just the same thing as the giant. When he tried to heel-and-toe the giant's garden, he got an answer different from the giant's. Why?" Let the children measure a "giant's garden" using both sets of cutouts. "Suppose John's shoe is used instead. What number do you think we might get?"

Observations

MEASUREMENT: TIME

Calendar Counting

Help children become aware of the functions of a calendar with a calendar placed in a convenient place. Call children's attention to the week. "How many days are in the week? How many days have passed so far this week? How many days are left in this week? How many days do we come to school? How many days for the weekend? How many weeks in ths month?"

Observations

TOPOLOGICAL SPACE

Farm Game

Build an enclosure with a "fence" and place some animals inside, some outside and some on the fence. Help the children understand these topological notions by asking them to place certain animals inside, outside, or on the fence. Ask them what happens when the gate is opened so that they are reminded that open and closed curves serve different purposes in real life situations.

Observations

TOPOLOGICAL SPACE

Inside, Outside

On the floor form a large circle with heavy string. Have groups of four to six children follow directions with respect to the circle. Have them stand inside, outside, on the boundary, have them walk forwards and backwards on the boundary.

Form an irregular closed figure. Have the children stand at different points and ask them if they are inside or outside the closed figure. Have them walk to one another, following the rule: they cannot cross over a boundary line.

Some closed figures you can form:

Observations

TOPOLOGICAL SPACE

Who Is Closest To? Who Is Farthest From?

With the children seated in particular locations in the room, ask "Who is closest to the door (sink, window, blocks, piano, etc.)? Change the question to "Who is farthest from . . .?" Have the children change places. Encourage the children to ask the questions.

Observations

TOPOLOGICAL SPACE

Balloon Fun

You will need several medium-sized balloons and a marking pen.

Blow up a balloon and draw a face on it. Let the children take turns to squeeze the baloon at various points to distort the face. Show how some properties of the shapes change (size) and others stay the same (open or closed shapes, inside or outside). Repeat with non-representational shapes drawings and ask children to predict what will happen to the shapes if you blow up the balloon more, if you let out some air, or if you squeeze it.

Observations

TOPOLOGICAL SPACE

Open and Closed Yarns

You will need yarn, glue and construction paper.

First, give children several lengths of yarn and ask them to form closed and not-closed curves on the table. If the children understand this concept, procede to the next step. If they are not sure, provide more opportunities for exploration.

Second, provide a piece of construction paper divided by a fold or a line. Ask children to make closed shapes with yarn and glue on one side of the paper and open, not-closed curves on the other side.

Observations

TOPOLOGICAL SPACE

The Pipe Cleaners Game

You need a good supply of pipe cleaners.

Have the children use pipe cleaners to form a variety of closed and not-closed curves. Ask each child to sort her shapes into two piles.

Observations

TOPOLOGICAL SPACE

Direction Word Play

You need string or masking tape, table, objects.

Divide the table in half by placing string or masking tape across the center of the table. Put two distinct objects, such as a small basket and a jar lid, on each side. Give the child a third object, such as a crayon, and tell her to:

Put the crayon under the basket.
Put the crayon on top of the lid.
Put the crayon in between the basket and the lid.
Make the crayon fly over the basket.
Put the crayon in the basket.
Put the crayon as close to the lid as possible.
Put the crayon as far away from the lid as possible.
Put the crayon into the lid, and put them both beside the basket.
Put the crayon opposite the lid.

Observations

This game can be played in small groups, giving children a turn to be in charge of the third object. Let other children participate with comments and evaluations. Later one child can be in charge of the crayon and another can give the directions.

PROBLEM SOLVING

Take One, Take Two

Place ten objects in front of two players. Each player may take one or two objects at her turn. Players alternate. The person who takes the last object wins.

Ask the children how they can be sure of winning. Would it be better to start first or second?

Try the game with more or fewer objects. Can the children see a pattern?

Observations

PROBLEM SOLVING

Logic Problems for Preschoolers

Provide a generous amount of square tiles.

Ask the children to arrange four tiles in as many different ways as they can think of. Have children count their own arrangements.

Repeat the activity asking children to use six tiles.

Observations

You will need a lot of tiles so the children's arrangements can be left intact while they are working.

PROBLEM SOLVING

Logic Problems for Preschoolers

You will need a set of attribute blocks.

Show one block at a time arranging them in a row. First, show the big circular blocks. "Let's find out what is in this package. Tell me what each object is as I take it out." Arrange the blocks in a row. Show the small circular blocks in the same color order as the large ones, arranging them under the large block of matching color. Have the children identify the first small circle. "What do you think the next block will be? What makes you think so?" Repeat with blocks of other shapes. "Tell me when you think the package will be empty," and so on.

Observations

PROBLEM SOLVING

Simple Word Problems for Preschoolers

1. "These crayons are for you. These crayons are for me. Who has more crayons, you or I?" Vary this problem varying the concrete materials used. When the child answers, refrain from saying right or wrong. Ask, "How do you know? How can you tell?" etc.

2. Provide a toy truck and several toy people. "These children are looking at the truck. One more child wants to see the truck. If that child comes, how many children will be looking at the truck?" Let children answer before you incorporate the toy into the group. Now let them count and decide if their answer was accurate. Repeat several times.

Observations

PROBLEM SOLVING

Word Problems for Preschoolers

1. Provide three toy cars. "Suppose you want to buy new tires for all of these cars. How many tires do you have to buy?"

2. "A bootmaker has two sons and one daughter. He is making boots for them. How many boots should he make?"

Observations

You can vary these problems endlessly to offer more problem-solving opportunities.

PROBLEM SOLVING

Word Problems for Preschoolers

1. Provide a little box and several toy people. "Suppose this is an elevator. This elevator can take only four people at a time. How many trips must the elevator make to carry all these people to the top floor?"

2. Provide dry dog food and five small containers. "How can we be sure that the five dogs who will eat from these dishes will each get the same amount? When can we count the pieces to be sure (when the pieces are the same size)? What can we do if the pieces are not all the same size?"

Observations

PROBLEM SOLVING

Word Problems for Preschoolers

"A gardener has four tomato plants in his garden. A friend gave him two more. He planted the plants his friend gave him and they all grew very well. Then another friend gave him one more tomato plant. He planted this one too and it grew. How many tomato plants did the gardener have in his garden?"

Observations

You can present this problem in many versions and many number combinations. Let children use their fingers or counters if they need help keeping track of the problem.

PROBLEM SOLVING

Word Problems for Preschoolers

Provide fifteen toy cars and simulate on a table a river on which a ferry (milk carton cut in half) moves back and forth. "This ferry must be used to get these cars across the river. The ferry can carry only three cars at a time. How many trips must the ferry make to get the cars across?"

Observations

If you provide several "ferries," you can ask, "Each ferry can carry only three cars at a time. How many ferries . . .?" If you provide five "ferries," you can ask, "Each ferry must carry the same number of cars. How many cars would be on each ferry?" Work with one version of the problem at a time. Repeat periodically.

PROBLEM SOLVING

Amazing Mazes

The child must find his way through increasingly obstructed paths. Simple mazes follow a path with no pitfalls. The next stage involves mazes with only one trick. As the child gets more experienced, mazes of increasing complexity are used.

Teachers can design their own mazes and then Xerox them so each child has her/his own copy.

Observations

Mazes are important because they require judgment and abstract reasoning ability.

PROBLEM SOLVING

Shape and Color Matrix

Make a matrix board out of a 12" x 12" piece of white tagboard by dividing it in sixteen squares. Make blobs of yellow, blue, and red on the vertical axis of the card. On the horizontal axis, draw the outlines of a triangle, circle, and square. Cover the card with contact paper. Use the appropriate shapes from the attribute blocks set.

Demonstrate to the children how to select a shape and then place it on the appropriate matrix, matching both color and shape. Then encourage the children to work on it as a group.

Observations

You can make additional boards and cards depicting objects that share two attributes such as three kinds of vehicles in three colors.

THREE-DIMENSIONAL SOLIDS

Matching Balls, Boxes, and Cans

You will need a ball, an orange, an onion, several types of boxes, several different cans (or objects similar to these).

Examine the different items, analyze their surfaces, edges, and corners. Discuss flat and round surfaces. Classify the shapes. Explore if they roll or not, and so on.

Observations

This is a great geometric activity that parents can carry out while putting away the groceries.

TWO-DIMENSIONAL SHAPES

Shape Walk

Take a group of children for a walk and look for a specific shape or for all the basic shapes. Stop whan a shape is identified and record it in a short sentence followed by the name of the child who spotted it. Return to school and briefly review your findings. Let the children draw and color shapes. Post your written record of the walk and the children's drawings if you wish.

Observations

TWO-DIMENSIONAL SHAPES

Shape Bingo

Make several Bingo-type cards divided in nine areas. Trace and color appropriately the shapes from the Pattern Block set. Make a spinner showing the same shapes.

For her turn the child spins and if she finds a figure on her card like the one indicated by the spinner, she takes such a shape from the tub and covers the appropriate space on her card. The winner must have three objects in a row or a full card. You may wish to let the children decide how the winner will be decided. You may prefer not to have a winner and play until all children fill their cards.

Observations

TWO-DIMENSIONAL SHAPES

Create A Shape

You will need a set of Pattern Blocks.

Place the Pattern Blocks in the center of a table with the children sitting around it. First, you will model and talk about how you can fit shapes together to make a new shape, "Find two squares and make a rectangle." After the children have become familiar with the task, the instructions may be given in pictorial form, on cards. (Divide each 4 x 6 index card in the middle with a line. Trace the required shapes on one side and the completed shape on the other side of the line.)

TWO-DIMENSIONAL SHAPES

Building Shapes

Provide children with tongue depressors or popsicle sticks. Let children play with the sticks, then model the construction of different geometric shapes. Ask children to copy the shapes you form. Count how many sticks are used for each shape. Introduce such shapes as the hexagon and the pentagon. Cut some sticks in half and let the children explore what happens if they use the shorter sticks.

Observations

After the children have done this activity on several occasions, children may form shapes with toothpicks and glue them on construction paper.

TWO-DIMENSIONAL SHAPES

The Geoboard

One or more children can participate in this activity. Geoboards are easily made or can be bought at school supply stores. You will need a box of different colored and different sized rubber bands.

The child (or children) will put the rubber bands around the nails in an unlimited number of combinations. They can create shapes such as rectangles, triangles, squares, or any shape that is angular. They can create shape inside another shape, divide up shapes or transform shapes. In small groups, one child will make a shape or design and the other children will try to duplicate it.

Observations

TWO-DIMENSIONAL SHAPES

Feel and Match

You need a set of attribute blocks or you can make cardboard cutouts of squares, circles, triangles, and rectangles.

Place several shapes in a feely bag and reserve one of each shape. Lay these on a table. Encourage the children to choose one shape and then reach into the bag and find the chosen shapes.

Observations